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IJST Contact Information:
P.O. Box 2793 Amman 11953 Jordan
Tel. +962796543469
E-mails: info@ijst-jo.com / ijst.jordan@yahoo.com
URL: www.ijst-jo.com

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FORWARD

Dear Colleagues,

IJST was a fruitful effort issued by the International Centre for Advancement of Sciences and Technology – ICAST, which tries to take part in both globalization and revolution in information and communication technologies, because S&T development becoming not only the key elements of economic growth and industrial competitiveness, but also essential for improving the social development, the quality of life and global environment. ICAST took then a decision to establish a scientific alliance with TSTC (Tharwa for scientific Training & Consultations) and this alliance comes to support the efforts towards publishing IJST.

Today, we announce a new issue of our journal, that is the fourth issue from the thirteen volume of IJST, December , 2018.

Finally, I hope that all significant figures of sciences whom joined the editorial board, the researchers, and the readers of our journal will keep IJST between their eyes and contribute in continuing its journey, with their remarks, valuable recommendations and their researching outcomes.

Thanks a lot for all who support IJST.

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Antileishmanial action of allopurinol and its analogues

Husain F. Hassan and Marwa A. Bakir

Dept. of Biology / College of Sciences / University of Kirkuk
Republic of Iraq

E- mail: marwa.kirkuk211@gmail.com

ABSTRACT

The growth inhibitory effects of allopurinol and its analogues , allopurinol riboside, 4-aminopyrazolopyrimidine (4APP), 4-aminopyrazolopyrimidine riboside (4APPR), 4-amino-6-mercaptopyrazolopyrimidine, mercaptopyrazolopyrimidine, tubercidine, deazopurine were tested against Leishmania tropica and L. donovani promastigotes. All exhibited antileishmanial activity in reducing promastigote numbers in in vitro culture medium. Allopurinol, Allopurinol riboside, 4APP and 4APPR were cause significant decrease in protein content and total nucleic acid content of both leishmanial promastigotes. They were also found to inhibit guanine phosphorribosyltransferase and hypoxanthin phosphoribosyltransferase to a considerable extent. Thus it can be suggested that the use of allopurinol analogues would be an excellent agents for antileishmanial chemotherapy.

Keywords: Antileishmanial action, allopurinol analogues

INTRODUCTION

Two pentavalent antimonials, namely sodium stibogluconate and meglumine antimoniate have been the front-line drugs for treatment of all forms of human leishmaniasis for many years (1), but frequently are failed to eradicate the parasite due to toxicities at high dosages, adverse side effects and lower efficacy (2).
The limitation on the use of these drugs have stimulated a widespread interest in evaluating alternative drugs. Allopurinol is a drug in use for the treatment of gout (3,4) It is supposed to function as an alternative substrate for the leishmanial enzyme hypoxanthine guanine phosphoribosyltransferase (HGPRT ase), so allowing the formation of allopurinol riboside monophosphate and its incorporation into RNA, which leads to the inhibition of protein synthesis in the parasite (5,6). In contrast, allopurinol is a poor substrate for the human HGPRTase and its ribotide is produced in minute quantities within the cell (7). Allopurinol, a purine analogue, has been used to treat leishmaniasis alone (8), or combined with other drugs such as antimonial compounds A noval combination uses ketoconazole and allopurinol , two drugs that have been individually suggested as second line treatments for visceral leishmaniasis (9). Low coat, stability , safety, ease of administration (oral), and lack of toxicity make allopurinol a particularly appealing drug for tropical and subtropical diseases.

MATERIALS AND METHODS

Parasite growth
The promastigote forms of *Leishmania tropica* and *Leishmania donovani* were grown at 26 C in PY medium as described by (10). Gentamicin sulphate was added at 25 mg\ml to inhibit bacterial growth.

Drug susceptibility experiments
Cultures were initiated at 5×10^5 parasite/ ml and drugs were added to appropriate concentrations, 24 hr. later. Drug solutions were freshly prepared and sterilized using a Millipore filter (0.22 μm). The number of motile parasite presented in the cultures were counted daily, using an improved Neubauer hemocytometer, until parasite growth entered stationary phase. The efficacy of the drugs is given in terms of the ED50 and ED90 the minimum concentration of drug used that reduce the number of promastigotes present after 3 days by 50% and 90% respectively.

Estimation of nucleic acids
To determine RNA and DNA contents, promastigotes grown in the presence (absence) of drug concentration causing 50% inhibition of growth were harvested by centrifugation at 3000 Xg at 4℃ for 10 min and washed twice with 0.85% (w\v) saline. It was then precipitated by resuspension in 5 ml of 0.2 N perchloric acid (PCA) at 0 C , and extracted twice at 0 C for 30 min with 0.2 N PCA. Lipid was then removed by two extraction at 45 C first with 75% (v/v) ethanol, and then with 10 ml of ethanol /ether (1:1), Finally, nucleic acids were extracted at 70 C for 40 min with 10 ml of 0.5 N PCA. The extract was then stored at 4 C for 48 hr. after which centrifuged at 3000 Xg for 15 min with the resultant supernatant (RNA and DNA) and pellet (phospholipid) being containing deoxyribonuclease (1 mg/ml) to the standard volume (15 ml). The amount of RNA was determined by the method of Plumer (11), using an Orcinol reagent with yeast RNA as standard whereas the amount of DNA was determined by the method of using diphenyl amine reagent (12).

Determination of protein concentration
To determine of protein content, promastigotes grown in the presence (absence) of drug concentration causing 50% inhibition of growth were harvested and washed as described above. It was then homogenized with 5 ml of cold 5% Trichloroacetic acid (TCA) to precipitate the protein. The homogenate was centrifuged at 3000 Xg for 10 min with resultant supernatant and pellet being separated. The supernatant was decanted and the pellet was washed with 5 ml of 5% TCA three times. The precipitated protein was then solubilized by 1N NaOH for 5 hr. with continuous shaking. The supernatant which contains the protein was taken and diluted with 1N NaOH to the standard volume (15 ml). The protein content was estimated by the method of Lowery (13) with bovine serum albumin as standard.

Preparation of cell extract
Mid log phase promastigotes (10^8 cells /ml) were centrifuged at 4500 Xg for 10 min at 4 C . Pellets were washed twice in phosphate buffered saline and lysed by sonication involving two 15 sec periods separated by a 30 sec cooling period using MSE soniprep 150 sec fitted with an exponential microprobe at 4 amplitude microns, Crude homogenates were centrifuged at 105000 Xg at 4℃ for 1 hr. and the resultant supernatant was used as source of the enzyme.

RESULTS

As indicated in (tables 1 and 2 , figures 1 and 2) the allopurinol and its analogs were found to inhibit the in vitro growth of promastigotes forms of both *L.tropica* and *L.donovani*. The inhibitory effect of the allopurinol analogs were leishmanistatic for both species, as promastigote forms eventually resumed their normal growth rates reaching control cellular growth within four days period, when subcultured into drug free medium. The promastigote forms of *L.tropica* were found to be more sensitive towards allopurinol analogs than *L.donovani*. When examined under the light microscope ,the allopurinol analogs treated promastigotes of both

leishmanial species were became immobile and spherical. Deazopurine was the most potent compound and caused at 10µM 90% and 82% growth inhibition of *L.tropica* and *L.donovani* promastigotes, respectively. Allopurinol, allopurinol riboside and tubercidin all exhibited antileishmanial activity and at 10µM by 4 days reduced the promastigotes number of *L.tropica* by 54%, 48% and 65% respectively and of *L.donovani* by 59% , 82% and 67%, respectively. 4-Aminopyrazolopyrmidine (4APP) was relatively less active than allopurinol and caused at 10µM 44% and 40% growth inhibition of promastigotes of *L.tropica* and *L.donovani* ,respectively. On the other hand, 4-aminopyrazolopyrimidine riboside (4APPR) at concentration 10 µM caused 70% and 74% growth inhibition of *L.tropica* and *L.donovani* promastigotes, respectively. 6-Mercaptopyrazolopyrimidine (MPP) and 4-amino-6-mercaptopyrazolopyrmidine (4A6MPP) were almost equally effective against both parasite forms and at 10 µM caused 88% , 44 % and 57 %, 84% growth inhibition of *L.tropica* and *L.donovani* promastigotes respectively.

Table (1): Effect of allopurinol analogues on the growth of *L.tropica* promastigotes

Drugs	Concentration (mM)	%Growth	%Inhibition	ED 50 (mM)	ED 90 (mM)
Allopurinol	0.01 0.1 1	46.3 30.4 19.5	53.7 69.6 80.5	0.0094	>1
4APP	0.001 0.01 0.1 1	68 56 48 40	32 44 52 60	0.09	>1
4A6MPP	0.001 0.01 0.1	97 52 18	3 48 82	0.0092	> 0.1
Allop.riboside	0.01 0.1 1	24.6 13.4 0.0	57.4 86.6 100	0.0087	>0.1
4APP riboside	0.001 0.01 0.1 1	36.5 30 8.5 3.5	63.5 70 91.5 96.5	0.00079	0.098
MPP	0.001 0.01 0.1 1	19.5 10.4 4.8 2.4	80.5 89.6 95.2 97.6	<0.001	0.01
Tubercidine	0.001 0.01 0.1 1	63.4 35.3 25.6 7.4	36.6 64.7 74.4 92.6	0.0078	0.97
Deazopurine	0.001 0.01 0.1 1	28 10 5 3.2	72 90 95 96.8	<0.001	0.01

Table (2): Effect of allopurinol analogues on the growth of *L.donovani* promastigotes

Drugs	Concentration (m M)	%Growth	%Inhibition	ED 50 (m M)	ED 90 (m M)
Allopurinol	0.01	41	59	0.0125	>1
	0.1	24	76		
	1	13	87		
4APP	0.001	72	28	1	>1
	0.01	60	40		
	0.1	54	44		
	1	50	50		
4A6MPP	0.001	30	70	<0.001	> 0.01
	0.01	18	82		
	0.1	0.0	100		
Allop.riboside	0.01	16	84	0.0059	>0.1
	0.1	4.8	95.2		
	1	0.0	100		
/APP riboside	0.001	40	60	0.00125	0.1
	0.01	26	74		
	0.1	10	90		
	1	3	97		
MPP	0.001	72	28	0.011	0.97
	0.01	56	44		
	0.1	35	65		
	1	7.8	92.2		
Tubercidine	0.001	51	49	0.0074	1.0
	0.01	33	67		
	0.1	23	77		
	1	11	89		
Deazopurine	0.001	45	55	<0.001	0.101
	0.01	18	82		
	0.1	11	89		
	1	3.3	96.7		

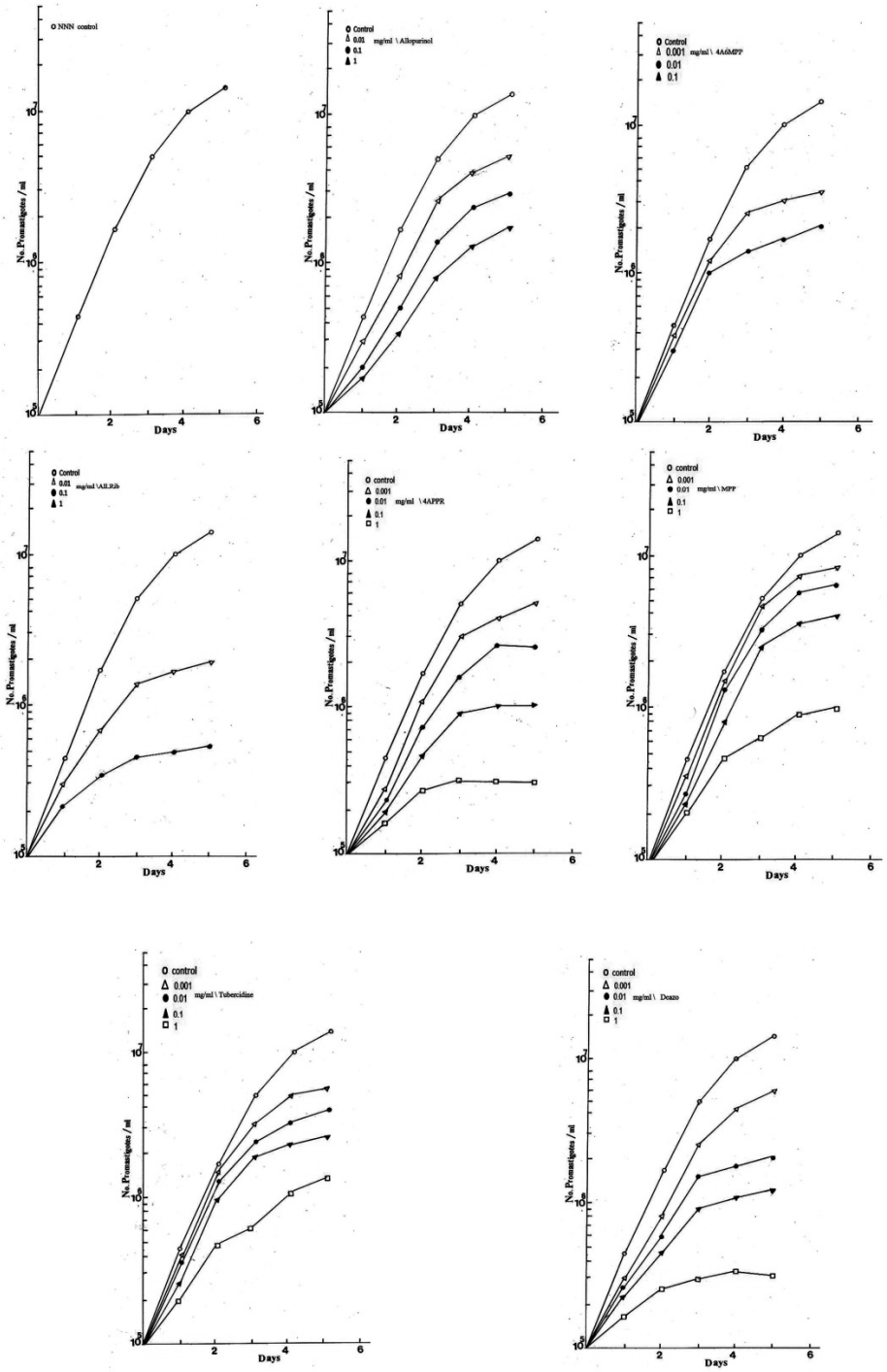

Figure (1): Effect of allopurinol analogues on growth of *L.tropica* promastigotes

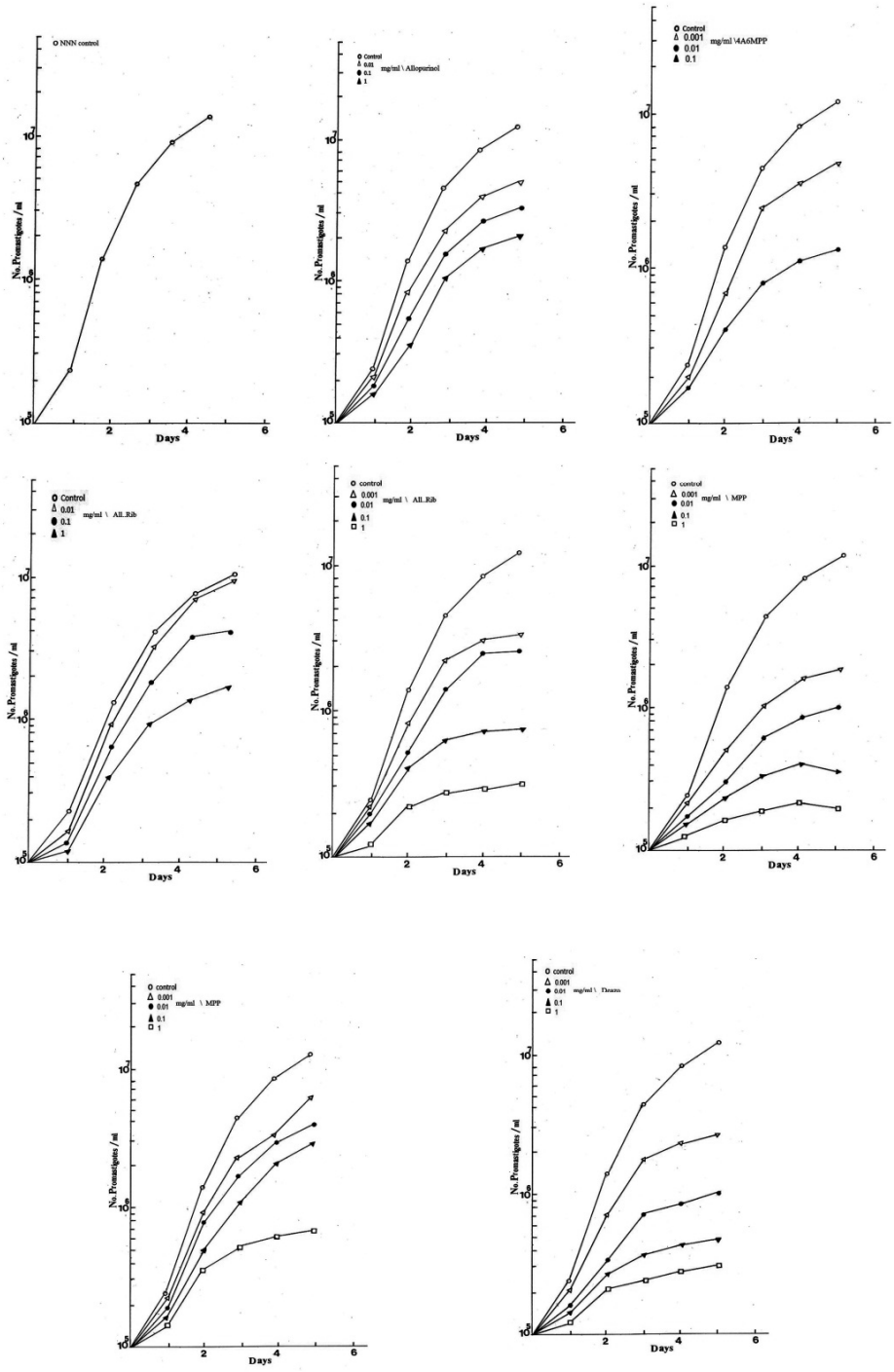

Figure (2): Effect of allopurinol analogues on growth of *L.donovani* promastigotes

The total protein content of promastigotes of *L.tropica* and *L.donovani* exposed to a drug concentration that reduce 50% of the growth over 4-days are represented in tables 3 and 4, respectively. Exposure of promastigotes of *L.tropica* and *L.donovani* to allopurinol, 4APP, 4A6MPP, 4APPR and Allopurinol riboside were caused (51%,49%, 40%, 34% and 36%) and (45%, 46%, 48%, 39% and 43%) decrease in protein content, respectively. On other hand, exposure of promastigotes of both parasites to other allopurinol analogues (MPP, tubercidin and deazopurine) were without marked effect on protein content.

Table (3): Effect of allopurinol analogues on total protein of *L. tropica* promastigotes

Drugs	10^7 cells /µg protein	Control %	Decrease%
Control	398 ± 8	100	-
Allopurinol	196± 6	49	51
4APP	204±6	51	49
4A6MPP	239± 9	60	40
Allop.riboside	256± 5	64	36
4APP riboside	264± 7	66	34
MPP	369± 10	93	7
Tubercidine	382 ± 4	96	4
Deazopurine	372± 5	93	7

Table (4): Effect of allopurinol analogues on total protein of *L.donovani* promastigotes

Drugs	10^7 cells /µg protein	Control %	Decrease%
Control	438 ± 5	100	-
Allopurinol	196± 6	45	55
4APP	238±7	54	46
4A6MPP	226± 4	52	48
Allop.riboside	241± 5	55	45
4APP riboside	265± 7	61	39
MPP	411± 9	94	6
Tubercidine	402 ± 11	92	8
Deazopurine	421± 8	96	4

Tables 5 and 6 outline the total nucleic acid content of promastigotes of *L.tropica* and *L.donovani* respectively, exposed to a drug concentration that reduced 50% of growth over 4 days. The results indicated that there were (57% and 52% and 42%) and (67%, 49% and 51%) decrease in amount of RNA in promastigotes of *L.tropica* and *L.donovani* exposed to allopurinol, 4APP and allopurinol riboside respectively. Others (MPP, tubercidin and deazopurine) were inactive. In contrast, there was slight effect on the DNA content of the promastigotes of both leishmanial species exposed to 50% inhibitory concentration of allopurinol analogues.

Table (5): Effect of allopurinol analogues on total nucleic acid content of *L.tropica* promastigotes

Drugs	µg RNA 10^7 / cells	Decrease%	µg DNA 10^7 / cells	Decrease%	Total nucleic / 10^7 cells	Decrease%
control	89±6	-	117	-	28±2	-
Allopurinol	38±6	54	54	43	16±2	57
4APP	43±3	46	64	25	21±3	52
4A6MPP	68± 7	27	86	36	18±4	24
Allop.riboside	52± 5	31	69	39	17±3	42
4APP riboside	70± 6	24	89	32	19±4	21
MPP	80± 6	11	105	11	25±3	10
Tubercidine	85 ± 7	6	111	7	26±2	4
Deazopurine	82± 4	9	107	11	25±3	8

Table (6): Effect of allopurinol analogues on total nucleic acid content of *L.donovani* promastigotes

Drugs	µg RNA 10^7 / cells	Decrease%	µg DNA 10^7 / cells	Decrease%	Total nucleic / 10^7 cells	Decrease%
control	-	102	-	24±3	-	78±8
Allopurinol	60	41	37	15±2	67	26±2
4APP	36	66	25	18±3	49	48±4
4A6MPP	48	54	33	16±3	38	38± 5
Allop.riboside	43	59	37	15±4	51	44± 3
4APP riboside	12	90	25	18±2	44	72± 7
MPP	8	94	8	22±4	8	72± 7
Tubercidine	9	93	12	21±2	8	72 ± 8
Deazopurine	5	97	4	23±5	5	74± 6

Drugs induced inhibition of guanine phosphoribosyltransferase (GPRTase) and hypoxanthin phosphpribosyltransferase (HPRTase) of *L. tropica* and *L.donovani* promastigotes are shown in tables 7 and 8, respectively . Allopurinol , 4APP and 4A6MPP were the only antileishmanial agents found to inhibit the GPRTase and the HPRTase to a great extent (more than 80%) in both *L.tropica and L. donovani* promastigotes.

Table (7): Effect of allopurinol analogues on *L.tropica* phosphoribosyltransferase

Drugs	HPRTase		GPRTase	
	Enzyme activity	Inhibition%	Enzyme activity	Inhibition%
Control	44±2	-	36±5	-
Allopurinol	5±1	89	6±1	83
4APP	7±1	84	7±2	81
4A6MPP	8±1	82	7±2	81
Allop.riboside	40±4	9	35±4	3
4APP riboside	39±6	11	34±5	6
MPP	41±5	7	36±3	NI
Tubercidine	43±3	2	35±6	3
Deazopurine	43±5	2	36±2	NI

Enzyme activity nomol /min /mg protein

Table (8): Effect of allopurinol analogues on *L.donovani* phosphoribosyltransferase

Drugs	HPRTase		GPRTase	
	Enzyme activity	Inhibition%	Enzyme activity	Inhibition%
Control	48±5	-	4±52	-
Allopurinol	7±1	85	9±2	83
4APP	8±2	83	8±3	85
4A6MPP	9±1	81	10±1	81
Allop.riboside	44±3	8	46±4	12
4APP riboside	44±2	8	45±3	13
MPP	46±5	4	48±2	8
Tubercidine	46±5	4	48±4	8
Deazopurine	48±6	NI	50±6	4

Enzyme activity nanomol / min / protein amalgam

DISCUSSION

The parasite growth and the effect upon it of allopurinol and its analogues , that were observed in this study are in agreement with the results observed by (14-16). It has been demonstrated that the selective toxicity of allopurinol and its analogues for leishmanial species may in part be due to their conversion to millimolar intracellular concentration of allopurinol-5-monophosphate ribotide and 6-aminoallopurinol-5- monophosphate by the parasites hypoxanthine-guanine phosphoribosyl transferase and adenine phosphoribosyltransferase activities, respectively (17,18).

The ribotide-5- phosphate formed then converted to smaller amount of ribotide-5-diphosphate and ribotide-5-triphosphate which is subsequently incorporated in to RNA , resulting in cytotoxicity to the parasite (19,20). The present study had reported that allopurinol and its analogues inhibit leishmanial hypoxanthine phosphoribosyltransferase

and guanine phosphoribosyltransferase activities and this could be due to their competing as substrates for the parasite enzyme . The inhibition of nucleic acid (RNA and DNA) synthesis of the promastigote forms by allopurinol and its analogues is consistent with the above hypothesis and suggests that a similar anti-metabolic activity may occur in the intracellular form of leishmanial species.

Allopurinol is remarkably nontoxic to mammalian cells and is resistant to nucleoside cleavage both in man and Leishmania (21). It may be possible to exploit the unusual enzymatic activities revealed in these studies in the development of a new chemotherapeutic approach for the treatment of leishmaniasis.

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Assessment of spring water quality at selected locations around Duhok city, Iraq

Ansam A. S. Al-Hamdany (1) and Musher R.A. Al- Barwary (2)

(1) Dept. of Environmental Sciences/ College of Environmental sciences and Technology/ University of Mosul (2) Dept. of Environmental Sciences/ College of Sciences / University of Zakho
Republic of Iraq

E –mail: ahmedansam@gmail.com

ABSTRACT

Spring water is the common source of public water supply in most village communities of developing countries such as Duhok city. The water samples were taken from the main water sources where maximum peoples were using them for drinking purpose. The objective of this research is to assess the suitability of spring water quality for drinking purpose at selected sites around Duhok city. Spring water samples were collected from Duske District and have been analyzed for physical and chemical parameters such as, Temperature, total alkalinity, total hardness (TH), total dissolved solids (TDS), electrical conductivity (EC),, pH, Chlorides (Cl-), Nitrite(NO3 -), Dissolved Oxygen (DO), Ca2+, Mg2+ and SO4 2- using American Public Health Association standard methods . The obtained values of each parameter were compared with the standard values set by World Health Organization. Monthly samples were collected from the springs during the period from April to October 2017. The statistical analysis of the experimentally estimated water quality parameters on water samples yielded the range of the variation, mean, standard deviation, co-efficient of variation, The results of analysis carried out showed that the following mean values of, Temperature ranges from(18.900± 1.575) °C to (19.95± 2.02)°C, dissolved oxygen ranges from (6.375±0.330)(7.725±0.435)mg/l, (NO3 -), from (1.175± 0.275) to (2.875 ± 1.506)mg/l, sulfate from (25.57±2.35) to (69.45±7.07)mg/l, magnesium from (75.00±16.87) to (124.50±15.00)mg/l, Ca2+, from (243.0 ±55.6) to (341.8±48.7)mg/l, total hardness from (300.8±65.1)to(454.0 ±48.4)mg/l, chloride from(51.40 ±2.12)to (126.43 ±11.26)mg/l, (TDS), from (359.8 ±34.1) to (822.0 ±87.0) mg/l, (EC) from (562.8±53.3) to (1284.8±135.9) µs/cm and pH from (7.3750 ±0.1500) to (8.1500 ±0.1291). About the total hardness it was found that all of the water quality characteristics were above the permissible limit but within the maximum permissible limit values. Calcium and magnesium were above the permissible limit. The results show that the concentrations of TDS are above the permissible limits at 6 locations. About sulfate, dissolved oxygen and (NO3 -),it was found that all of the water quality parameters were within the permissible limit. The study recommends that most of the spring water needs treatment to protect the households from drinking water.

Keywords: spring water, statistical analysis, water quality, Duhok city, Kurdistan region.

INTRODUCTION

Spring water is the common source of public water supply in most rural communities of developing countries such as the Kurdistan region. Improving access to safe drinking-water is of major benefit to the human health and every effort should be made to achieve a drinking-water quality as safe as practicable (1). Springs are the principal source of domestic water supply for rural communities in the Kurdistan region; when they dry up or decline, the resulting water shortages become a major environmental threat (2). Springs are very important elements of the natural environment, especially in the areas that are under legal protection. In order to better understand protected areas, one should pay particular attention to identifying water conditions, both quantitative and qualitative. Springs being natural groundwater outflows respond well to any changes that occur in natural ecosystems (3). All life forms especially humans depend on their surrounding biophysical environment for their well-being and survival but due to overuse of these resources, the environment has been degrading rapidly. Among these fundamental resources, water is one of the most important natural resources for humans, wildlife and the whole environment. Assessment of ambient water quality determines its use for humans and ecological purposes (4). Anthropogenic activities make the surface and ground water highly polluted owing to the fact that surface water is extensively being used in industrial activities, agriculture sector, domestic and municipal facilities. As clean water is highly demanded, it can be derived from various sources but unfortunately, surface waters most often have the threat of begin polluted and their low quality status leads to public health issues (5). Water pollution can be prevented by stopping pollutants from contaminating nearby water sources. There are a number of water treatments to prevent pollution and water quality such as biological filters, chemical additives and sand filters. These simple techniques cost money to maintain, but prevention is much cheaper than cleaning up water pollution that has already occurred (6). Peoples living around the study area are also seeking the spring water as drinking and other domestic purposes. Considering this situation a good knowledge of the qualities of spring water is necessary to guide its suitability for use (7), also stated that physicochemical characteristics are vital to water quality monitoring parameters and affect the quality of a water resource. Therefore; the present study was formulated to determine the potability of the spring water by assessing the levels of some physicochemical parameters, which justifies the quality of drinking water. The main sources of water are rain water, and groundwater (wells, boreholes, and springs). A spring can be described as any natural occurrence where water flows on to the surface of the earth from below underneath. Springs may result from karst topography where surface water has infiltrated into the earth's surface, becoming part of the area's ground water that travels through a network of cracks and fissures ranging from intergranular spaces to large caves. The water eventually emerges from below the surface, in the form of a spring (8). The objectives of the present study were to analyze the chemical and physical parameters of spring water for drinking purpose.

MATERIALS AND METHODS

The present study was carried out on the spring water quality of eleven springs of the Doske district, within Duhok governorate, with the aim of assessing the drinking water quality. Samples were collected monthly from the springs during the period from April to October 2017. A total of 132 samples were collected in sterilized white polyethylene bottles were analyzed immediately for chemical and physical characteristics, such as Total Hardness (TH), Ca++, Mg++, total dissolved solids (TDS), electrical conductivity (EC), PH, Nitrate and Sulfate (SO4), Nitrate (NO3) was determined by American Public Health Association standard methods (9), within 48 hours. 132 water samples were collected from various spring water sources located in (figure 1) a map view of sampling locations of the study area. Statistical analysis: Descriptive statistics were used to calculate the mean and Standard deviation and variation coefficient. The data obtained were subjected to statistical analysis using (SPSS) programs; the two-tailed test of significance ($p < 0.05$) was used to determine the significance of the result.

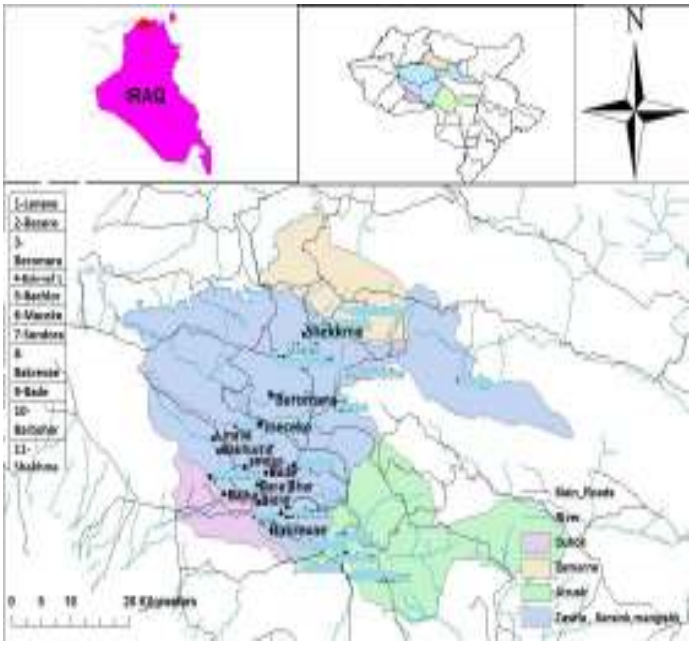

Figure (1): a map view of sampling locations of the study area

RESULTS AND DISCUSSION

Temperature (T°C): Temperature is an important parameter of water quality to all chemical and biological reactions in aquatic ecosystems. The mean values of spring water temperature of the study area range from (18.900 ± 1.575) °C to (19.95 ± 2.02) °C. The maximum temperature was recorded at sites 5 was 22.3°C, and the minimum temperature was recorded at location 9 was 17.3 °C, as shown in table (1).

From the result of temperature, there are no significant variations because the difference value for the minimum and the maximum temperature is 1.3˚C, and fall within the acceptable limit of 27°C, set by World Health Organization standard (6). Similar results were reported by Mosher (10).

Table (1): Statistical description of temperature (T°C) of spring water samples

Sites	Mean	S.E	S.D	C.V	Min	Max	Range
1	19.95	1.01	2.02	4.10	18.10	21.80	3.70
2	18.950	0.750	1.500	2.250	17.400	20.600	3.200
3	19.175	0.861	1.721	2.962	17.600	21.500	3.900
4	19.225	0.550	1.100	1.209	18.000	20.500	2.500
5	20.025	0.999	1.999	3.996	18.200	22.300	4.100
6	19.025	0.675	1.350	1.822	17.700	20.900	3.200
7	19.250	0.729	1.457	2.123	18.300	21.400	3.100
8	19.20	1.01	2.02	4.10	17.40	22.00	4.60
9	18.900	0.787	1.575	2.480	17.300	20.700	3.400
10	19.250	0.487	0.975	0.950	18.100	20.200	2.100
11	18.975	0.541	1.081	1.169	17.600	20.100	2.500

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; S.E. The standard error of the mean; Values from three replicates. Means with different letters vertically have a significant difference at p≤0.05

In the present study the mean of pH value of all water samples ranged from (7.3750 ±0.1500) to (8.1500 ±0.1291). Table (2) shows significant variation in water pH between the studied springs. The minimum pH was recorded as 7.2000 at location (1) and the maximum was 8.3000 at the site (11). Drinking water with a pH from 6.5 to 8.5 is generally considered satisfactory.

Table (2): Statistical description of pH of spring water samples

Sites	Mean	S.E	S.D	V.C	Min	Max	Range
1	7.3750	0.0750	0.1500	0.0225	7.2000	7.5000	0.3000
2	7.5750	0.0750	0.1500	0.0225	7.4000	7.7000	0.3000
3	8.1250	0.0479	0.0957	0.0092	8.0000	8.2000	0.2000
4	7.6500	0.0645	0.1291	0.0167	7.5000	7.8000	0.3000
5	7.8750	0.0629	0.1258	0.0158	7.7000	8.0000	0.3000
6	7.6250	0.0479	0.0957	0.0092	7.5000	7.7000	0.2000
7	7.9500	0.0645	0.1291	0.0167	7.8000	8.1000	0.3000
8	7.875	0.125	0.250	0.062	7.600	8.200	0.600
9	7.9500	0.0645	0.1291	0.0167	7.8000	8.1000	0.3000
10	7.6000	0.0816	0.1633	0.0267	7.4000	7.8000	0.4000
11	8.1500	0.0645	0.1291	0.0167	8.0000	8.3000	0.3000

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; S.E. The standard error of the mean; Values from three replicates. Means with different letters vertically have a significant difference at p≤0.05

These pH values fall within the acceptable limit of (6.5–8.5) according to WHO, (6), pH values showed significant variations at $p < 0.05$). In this paper are significantly higher than those reported by Maindoli, *et al* . (11).

Electrical Conductivity (EC) in µs/cm: The mean concentration of electrical conductivity was found to be in the range from (562.8±53.3) to (1284.8±135.9) µs/cm. There was a statistically significant variation at ($p < 0.05$) among the mean electrical conductivities of the different water sources. Higher electrical conductivities values were observed indicating the presence of high amount of bicarbonate and calcium ions present in the rocks. The minimum concentration of (496.0) µs/cm was recorded at the site (1), while the maximum concentration of (1411.0) µs/cm was recorded at the site (4). Electrical conductivity values showed significant variations at $p < 0.05$) (Table 3). The values obtained in all sampling sites were within the standard value of WHO drinking water quality which is 1000 µS/cm, except 3 locations (4, 5 and 10). But all the mean of electrical conductivities values of the water sources were below the maximum guideline limit of 1500 µs/cm set by WHO, 2014 (12). The values here are significantly lower than those reported by (13).

Table (3): Statistical description of electrical conductivity µs/cm of spring water samples

Sites	Mean	S.E	S.D	V.C	Min	Max	Range
1	562.8	26.7	53.3	2844.3	496.0	621.0	125.0
2	912.5	31.6	63.1	3981.7	827.0	979.0	152.0
3	956.3	35.2	70.4	4957.6	853.0	1010.0	157.0
4	1284.8	68.0	135.9	18472.3	1108.0	1411.0	303.0
5	1267.0	65.0	130.0	16893.3	1083.0	1385.0	302.0
6	466.5	23.2	46.3	2145.0	410.0	518.0	108.0
7	725.0	32.4	64.7	4191.3	639.0	793.0	154.0
8	630.0	22.0	44.0	1936.7	573.0	672.0	99.0
9	851	128	257	65852	617	1108	491
10	1149.8	74.7	149.3	22296.2	968.0	1322.0	354.0
11	568.0	32.6	65.2	4251.3	486.0	638.0	152.0

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; S.E. The standard error of the mean; Values from three replicates. Means with different letters vertically have a significant difference at p≤0.05

Total dissolved solids (TDS) in mg/l: In this study the mean concentration of total dissolved solids of spring water varied from (359.8 ±34.1) to (822.0 ±87.0) mg/l. The maximum concentration of total dissolved solids was recorded at location 1 and the minimum concentration of total dissolved solids was recorded at location 4. Table (4) shows a significant variation in the electrical conductivity among the studied spring water. The major determinant of the total dissolved solids level in water is the geochemical properties of the ground it comes in contact with. In this study, the total dissolved solids are found within the permissible limit of 500 mg/l, set by (1), except (6) locations which are above the permissible limit. In this paper are significantly lower than those reported by (14) and higher than those reported by (15).

Table (4): Statistical description of total dissolved solids mg/l of spring water samples

Sites	Mean	S.E	S.D	V.C	Min	Max	Range
1	359.8	17.1	34.1	1164.9	317.0	397.0	80.0
2	554.5	20.6	41.2	1697.7	510.0	592.0	82.0
3	611.3	22.6	45.2	2041.6	545.0	646.0	101.0
4	822.0	43.5	87.0	7576.7	709.0	903.0	194.0
5	810.5	41.5	83.1	6900.3	693.0	886.0	193.0
6	298.3	14.8	29.6	878.2	262.0	331.0	69.0
7	463.5	20.9	41.7	1741.7	408.0	507.0	99.0
8	402.8	14.2	28.3	800.9	366.0	430.0	64.0
9	543.8	82.2	164.4	27034.3	394.0	709.0	315.0
10	735.5	47.9	95.8	9180.3	619.0	846.0	227.0
11	363.3	20.8	41.7	1736.9	311.0	408.0	97.0

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; S.E. The standard error of the mean; Values from three replicates. Means with different letters vertically have a significant difference at p≤0.05

Total alkalinity (TA) in mg/l: Table (5) shows a significant variation in the total alkalinity among the studied spring water. The maximum minimum concentration of total alkalinity is observed as (452.0) mg/l, and the minimum concentration is (158.0) mg/l. Alkalinity is mainly caused by carbonates, hydroxide and bicarbonate of alkali earth metal. According to WHO, 2008 (10), the desired limit and the maximum permissible limit for alkalinity in drinking water is 200 and 600 mg/L respectively. Total alkalinity values showed significant variations at $p < 0.05$. In this study are significantly higher than those reported by (17,18). In this study, the alkalinity level was found above the desired limits (200mg/l), and less than the permissible limit (600 mg/l) set by WHO (13).

Table (5): Statistical description of total alkalinity of spring water samples

Sites	Mean	S.E	S.D	V.C	Min	Max	Range
1	190.50	8.61	17.21	296.33	169.00	208.00	39.00
2	355.8	23.4	46.8	2192.9	288.0	389.0	101.0
3	185.0	11.0	22.0	484.7	158.0	210.0	52.0
4	405.3	17.8	35.7	1271.6	359.0	438.0	79.0
5	369.5	19.7	39.4	1549.7	327.0	410.0	83.0
6	328.8	22.3	44.7	1997.6	275.0	377.0	102.0
7	250.0	34.3	68.6	4710.7	193.0	339.0	146.0
8	283.0	13.9	27.8	774.7	248.0	310.0	62.0
9	423.3	17.4	34.8	1210.9	373.0	452.0	79.0
10	354.3	26.0	52.0	2702.3	285.0	411.0	126.0
11	358.3	60.8	121.7	14808.9	179.0	449.0	270.0

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; S.E. The standard error of the mean; Values from three replicates. Means with different letters vertically have a significant difference at p≤0.05

Chloride ion (Cl^-) in mg/l: In the present study, the mean concentration of chloride was found in the range of(51.40 ±2.12) to (126.43 ±11.26) mg/l. (table 6). All the concentrations recorded were within the permissible standard of 250 mg/l set by (12). They have a significant variation at $p<0.05$. The minimum concentration of chloride was recorded at location (1) was (48.50) mg/l, and the maximum concentration was recorded at location (10) was (137.90) mg/l. The chloride value exhibits small variation within the springs and the variation may be due to the same recharge zone and source of impurities that add chlorides. Similar results were reported by (10,19).

Table (6): Statistical description of chloride mg/l of spring water samples

Sites	Mean	S.E	S.D	V.C	Min	Max	Range
1	51.40	1.06	2.12	4.51	48.50	53.60	5.10
2	59.50	1.67	3.34	11.14	55.10	62.90	7.80
3	78.70	3.13	6.26	39.25	69.70	84.00	14.30
4	103.85	7.84	15.67	245.64	84.50	121.10	36.60
5	119.62	9.23	18.45	340.44	93.70	135.10	41.40
6	70.13	5.89	11.79	138.96	59.80	87.10	27.30
7	79.95	1.11	2.23	4.97	77.30	82.70	5.40
8	121.55	7.64	15.27	233.29	100.90	137.50	36.60
9	99.70	4.62	9.25	85.55	87.50	108.30	20.80
10	126.43	5.63	11.26	126.73	111.60	137.90	26.30
11	72.32	1.18	2.37	5.61	69.40	74.30	4.90

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; S.E. The standard error of the mean; Values from three replicates. Means with different letters vertically have a significant difference at p≤0.05

Total Hardness (TH) in mg/l as CaCO3: The desirable limit of total hardness of drinking water according to WHO., 2012 (13), standard is 300 mg/l as CaCO3, for drinking water. The mean concentration of total hardness in spring water samples ranged from (300.8±65.1) to (454.0 ±48.4)mg/l. (table 7). Hardness values of the all spring water samples were exceeding the permissible limit of 300 mg/l as CaCO3, but all the values were within maximum limit value 500mg/l. They have a significant difference at $p<0.05$. The maximum concentration was recorded at location (6) was (490.0) mg/l, and the minimum value was recorded at location (7) was (219.0) mg/l. These high values of total hardness may be caused by naturally occurring minerals, which dissolve as water moves through soil and rock deep underground and into the ground water supply. In this study are significantly higher than those reported by (20), and lower than those reported by (14).

Table (7): Statistical description of total hardness mg/l of spring water samples

Sites	Mean	S.E	S.D	V.C	Min	Max	Range
1	370.0	12.7	25.4	647.3	341.0	396.0	55.0
2	385.3	16.4	32.9	1081.6	339.0	412.0	73.0
3	300.8	32.5	65.1	4232.3	219.0	372.0	153.0
4	433.8	27.1	54.3	2943.6	360.0	485.0	125.0
5	342.5	24.0	47.9	2296.3	274.0	381.0	107.0
6	454.0	24.2	48.4	2338.7	384.0	490.0	106.0
7	315.8	34.1	68.1	4640.9	219.0	372.0	153.0
8	416.8	23.4	46.8	2188.3	351.0	459.0	108.0
9	379.5	20.7	41.5	1720.3	319.0	407.0	88.0
10	387.3	23.5	47.1	2214.9	325.0	438.0	113.0
11	385.5	31.7	63.3	4011.0	311.0	464.0	153.0

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; SE. The standard error of the mean; Values from three replicates. Means with different letters vertically have a significant difference at p≤ 0.05.

Calcium (Ca^{2+}) in mg/l as CaCO3: Ca^{2+} has no effect on human health in water, but it can cause hardness problem risk and directly related to hardness (21). In the present study, the mean values of calcium hardness are ranges from (243.0 ±55.6) to (341.8±48.7) mg/l. Table (8) shows a significant variation in the calcium (Ca2 +) among the studied spring water. All the values of Ca2+ were exceeding the standard values of WHO (75 mg/L) and US-EPA (75-100 mg/L). They have a significant difference at $p< 0.05$. The maximum value of 382.0 mg/l is recorded at location 6 and the minimum value of (167.0) mg/l is recorded at location 7. For all the samples the values of calcium were found above the maximum permissible limit (200mg/l), except 2 sites. In this study are significantly higher than those reported by (22).

Table (8): Statistical description of calcium hardness mg/l in spring water samples

Sites	Mean	S.E	S.D	V.C	Min	Max	Range
1	279.5	12.2	24.4	597.7	264.0	316.0	52.0
2	302.0	25.5	51.0	2596.7	248.0	371.0	123.0
3	243.0	27.8	55.6	3095.3	185.0	295.0	110.0
4	331.5	15.0	30.1	905.7	299.0	369.0	70.0
5	256.8	26.6	53.2	2834.3	178.0	295.0	117.0
6	329.5	24.1	48.2	2323.7	268.0	382.0	114.0
7	257.8	31.3	62.7	3928.9	167.0	311.0	144.0
8	341.8	24.3	48.7	2370.9	269.0	372.0	103.0
9	303.5	12.9	25.9	669.7	279.0	331.0	52.0
10	283.5	16.1	32.3	1041.7	249.0	312.0	63.0
11	280.5	31.6	63.2	3988.3	220.0	361.0	141.0

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; S.E. The standard error of the mean; Values from three replicates. Means with different letters vertically have a significant difference at p≤0.05

Magnesium Mg2+ in mg/l as CaCO3: In this study the analyzed samples (table 9) show means contents of magnesium were ranging from (75.00 ±16.87) to (124.50 ±15.00) mg/l. They have a significant difference at $p<0.05$. The maximum value was recorded at site 4 was (167.0) mg/l and the minimum value was recorded at site 3 was (34.0) mg/l. The desirable limits of magnesium for drinking water are 30 mg/l, all the samples record values above 30 mg/l, and most samples recorded the magnesium values within the permissible limit of 100 mg/l set by (23), except 4 locations. In this study are significantly higher than those reported by (10, 18).

Table (9): Statistical description of magnesium hardness mg/l of spring water samples

Sites	Mean	S.E	S.D	V.C	Min	Max	Range
1	90.5	11.0	22.0	483.7	72.0	122.0	50.0
2	83.3	23.9	47.8	2284.2	41.0	137.0	96.0
3	57.8	11.8	23.6	555.6	34.0	79.0	45.0
4	102.3	22.7	45.4	2058.3	61.0	167.0	106.0
5	85.75	6.96	13.91	193.58	66.00	96.00	30.00
6	124.50	7.50	15.00	225.00	108.00	140.00	32.00
7	58.00	6.26	12.52	156.67	45.00	74.00	29.00
8	75.00	8.44	16.87	284.67	57.00	95.00	38.00
9	76.0	13.2	26.4	698.0	40.0	102.0	62.0
10	103.8	21.2	42.4	1797.6	62.0	152.0	90.0
11	105.0	17.0	34.1	1160.0	69.0	151.0	82.0

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; S.E. The standard error of the mean; Values from three replicates. Means with different letters vertically have a significant difference at p≤0.05

Sulfate (SO_4^{2-}) in mg/l: In the present study, the mean concentration of sulfate observed in the range from (25.57 ±2.35) to (69.45±7.07)mg/l, during the study period. Table (10) shows a significant variation in the sulfate among the studied spring water. The minimum concentration of sulfate was observed at location (7) was (22.40) mg/l, and maximum concentration of sulfate was observed at location (10) was (92.80) mg/l. Sulfate occurs naturally in waters as a result of leaching from gypsum and other common minerals. Sulfate content in all sample locations is found to fall within the permissible limit standard of 400 mg/l set by WHO., 2011 (23). All the spring water appears to be suitable for drinking purposes in respect of SO4. They have a significant difference at $p<0.05$. In this study are significantly lower than those reported by (24).

Table (10): Statistical description of sulfate SO4 2- mg/l of spring water samples

Sites	Mean	S.E	S.D	V.C	Min	Max	Range
1	28.80	1.15	2.30	5.27	25.90	31.40	5.50
2	38.83	2.83	5.66	32.02	31.80	44.70	12.90
3	45.48	3.89	7.77	60.44	36.50	53.90	17.40
4	67.33	4.65	9.30	86.55	54.70	76.50	21.80
5	69.45	3.53	7.07	49.98	61.00	78.30	17.30
6	28.90	1.60	3.20	10.26	25.10	32.60	7.50
7	25.57	1.18	2.35	5.54	22.40	27.80	5.40
8	38.55	1.37	2.73	7.46	35.10	41.70	6.60
9	61.82	6.10	12.20	148.76	48.60	75.30	26.70
10	81.90	4.54	9.07	82.29	71.60	92.80	21.20
11	28.50	2.17	4.35	18.91	22.90	33.50	10.60

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; S.E. Standard error of the mean; Values from three replicates. Means with different letters vertically have significant difference at p≤0.05

Nitrates (NO_3^-) in mg/l: In the present study the values of nitrate in all the sampling Locations ranges from (1.175± 0.275) to (2.875 ± 1.506) mg/l, (Table 11) shows a significant variation of the nitrates among the studied spring water. The maximum value of 4.400 mg/l is recorded at site 9 and the minimum value of 0.800 mg/l is recorded at site 2. Nitrates are present in water by the leaching of nitrogen products into the soil by decomposition of organic matter or synthetic or natural fertilizers (7). This concentration was within the standard limits of drinking water quality set by WHO., 2009 (1), 45 mg/l. They have a significant difference at $p<0.05$. Similar results reported by Mosher (10).

Table (11): Statistical description of nitrate NO3-mg/l of spring water samples

Sites	Mean	S.E	S.D	V.C	Min	Max	Range
1	1.425	0.175	0.350	0.123	1.000	1.800	0.800
2	1.575	0.315	0.629	0.396	1.000	2.300	1.300
3	1.575	0.330	0.660	0.436	0.800	2.300	1.500
4	2.025	0.210	0.419	0.176	1.600	2.600	1.000
5	1.825	0.616	1.231	1.516	0.900	3.600	2.700
6	1.325	0.197	0.395	0.156	1.000	1.900	0.900
7	1.850	0.210	0.420	0.177	1.300	2.300	1.000
8	1.275	0.180	0.359	0.129	0.800	1.600	0.800
9	2.875	0.753	1.506	2.269	1.300	4.400	3.100
10	2.475	0.312	0.624	0.389	1.800	3.100	1.300
11	1.175	0.138	0.275	0.076	0.900	1.500	0.600

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; S.E. Standard error of the mean; Values from three replicates. Means with different letters vertically have significant difference at p≤0.05

Dissolved oxygen (DO) in mg/l: In the present study the mean concentration of dissolved oxygen in all the sampling sites ranges from (6.375±0.330) (7.725±0.435)mg/l. (table 12). The values of dissolved oxygen shows variation within a range from a maximum of (8.100) mg/l, at location (7), and the minimum values of (6.100) mg/l, at location (9). The higher value of dissolved oxygen may be due to the influence of run-off water from spring and winter rain. They have a significant difference at $p<0.05$. In this study are significantly higher than those reported by (25).

Table (12): Statistical description of dissolved oxygen mg/l of spring water samples

Sites	Mean	S.E	S.D	V.C	Min	Max	Range
1	7.225	0.103	0.206	0.043	7.000	7.500	0.500
2	7.175	0.165	0.330	0.109	6.700	7.400	0.700
3	6.650	0.126	0.252	0.063	6.400	7.000	0.600
4	6.375	0.165	0.330	0.109	6.000	6.800	0.800
5	6.925	0.202	0.403	0.163	6.500	7.400	0.900
6	7.425	0.138	0.275	0.076	7.100	7.700	0.600
7	7.725	0.217	0.435	0.189	7.100	8.100	1.000
8	7.500	0.242	0.483	0.233	6.800	7.900	1.100
9	6.625	0.193	0.386	0.149	6.100	7.000	0.900
10	6.475	0.118	0.236	0.056	6.300	6.800	0.500
11	7.525	0.111	0.222	0.049	7.300	7.800	0.500

Min.: Minimum; Max.: Maximum; SD- standard deviation; C.V: coefficient of variation; Mean value ±S.D. standard deviation; S.E. Standard error of the mean; Values from three replicates. Means with different letters vertically have significant difference at $p \leq 0.05$

CONCLUSION

The results derived from the study shows that 6 locations for the total hardness of the water samples were above the permissible levels recommended by the WHO. This needs purification of spring water to ensure good water quality. The results obtained in this study, by the analyzes of these waters in the laboratory, shows that the majority of the samples collected in the region are generally of good quality in terms of pH, conductivity, temperature, chloride, sulfate, nitrate, total alkalinity, sulfate and dissolved oxygen, which fall within permissible levels. From the experimental data it was found that the concentration of TDS of 6 sites was higher than the permissible levels of TDS for safe drinking water set by WHO (500 mg/l). It is recommended that water analysis should be carried out from time to time to maintain the cleanness of water at their highest quality and purity levels to achieve a healthy life.

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Application of (MBBR) technique for treatment medical wastewater

Farah Touma Al- Gizzy and Hayder M. Abdul-Hameed

Dept. of Environmental Engineering / College of Engineering / University of Baghdad
Republic of Iraq

E –mail: hayderabdul_hameed@yahoo.com

ABSTRACT

The moving bed biofilm reactor (MBBR) is a biological wastewater treatment process in which microorganisms grow as biofilms on suspended carriers. Conventionally, MBBRs are mainly designed and optimized based on the carrier surface area. The MBBR performance was evaluated in several lab studies, considering different aspects such as carrier design and operational strategies, involving both carrier design and operational strategies. The waste used in the study was local hospital waste water (Ibn al-Nafees Hospital).

Keywords: Biological wastewater treatment, moving bed biofilm reactor; nitrification, organic removal, process optimization

INTRODUCTION

The significance of the environmental factors to the health and well-being of human populations is increasingly apparent, as the environmental pollution is a worldwide problem that is affecting the health of human around the globe (1). Pollution may considered to be a process consisting of any modification of the environmental components due to natural (or /and), human activities from an industrial, agricultural, commercial, residential and other activity (2). Hospital wastewater is wastewater generated from all activities of the hospital due to medical and nonmedical activities from the operating, emergency, first aid, laboratory, diagnosis, radiology, kitchen and laundry activities (3). It contains harmful pollutants, such as: pathogenic microorganisms bacteria, viruses, residual of medicine and laboratory chemicals (antibiotics, phenol, chloroform), chemical toxic (Pb), and biodegradable organic material (protein, fat, carbohydrate) (4). The wastewater is normally discharged directly, without pre-treatment, to sewers. Despite mostly being only a small fraction of the total wastewater volume in the influent of a sewage treatment plant (STP), There are different traditional biological methods of wastewater treatment such as; trickling filter are classified by hydraulic and organic loading, activated sludge. The moving bed bioreactor (MBBR) treatment process is the treatment of the incoming wastewater by microorganisms growing in a biofilm on biocarriers suspended in the liquor in the MBBR reactor. The biocarriers “carry” the microorganism's through-out the reactors (5). Microorganisms in the outer layers of the biofilm have “first access” to the dissolved oxygen and substrate diffusing through the biofilm (6). Part of the design of each (MBBR) reactor is an aeration system the decrease of available dissolved oxygen through the biofilm produces aerobic anoxic and anaerobic layers in the biofilm (7). The biological denitrification is recommended for the removal of relatively low concentration of nitrogen components and it is operated by the so called denitrifying bacteria in anoxic conditions, where they use nitrates as electron acceptors during their respiratory process in the place of the oxygen.

MATERIALS AND METHODS

The experimental part

Set up consisted of an MBBR reactor and carbon column. The MBBR reactor was a circular tank. The air entered through a circular sparger ring at the bottom of the tank also air distributor, both of them provide better transfer of oxygen to the liquid. The carbon column was constructed of in Acrylic tube. The column was filled with granular activated carbon .A flow diagram of the system is shown in figure (1).

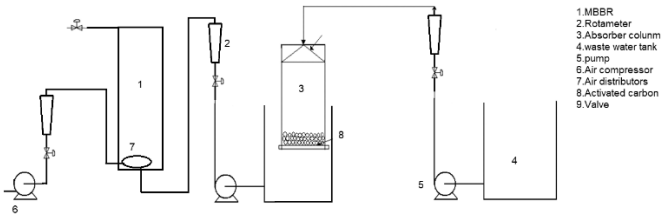

Figure (1): schematic diagram of the system

The wastewater that collected from the hospital first filter from any solid material that could block the water pump. The wastewater pumped from the tank to the top activated carbon column were the first wastewater treatment occur. The treated wastewater collected in a tank below the activated carbon column. The wastewater then pumped to the MBBR reactor from the bottom were the reactor contain the biofilm media. air is also introduced at the desirable flow rate to the column were flotation of the media occur and rise to the top of the reactor. Finally at the top a sample value were used to take sample for analysis.

MBBR media

Two different type of the MBBR media were used from different origin the HDPE media and LDPE media.

Wastewater

Ibn Al-Nafees Hospital is hospital specialized in cardiothoracic surgery, which was acquired by the Iraqi Ministry of Health. The hospital is located in Al-Andalus Square in the Rusafa side of Baghdad, Iraq. The hospital operates referral system at a rate of more than 2500 references per month. It’s considering one of important hospital in Iraq (table 1).

Table:(1) The properties of the average analyzed samples

Measure	Value
PH	7.3-8.2
S.S	(0.2-1)g/L
TDS	(1382-455)ppm
E.C	(2900-610)µs/cm
DO	(370-400) mg/L
BOD	(400-430) mg/L
COD	(240-250) mg/L
NO3	58.17 ppm
PO4	6.607 ppm

RESULTS AND DISCUSSION

The effect of the activated carbon bed height

A bed height of (2,4,6) cm were used to investigated the influence of the changing this parameter on the (phosphate conc., nitrate conc.) respectively and the results are presented as shown in figures (2 and 3) by keeping all the other operational conditions constant.

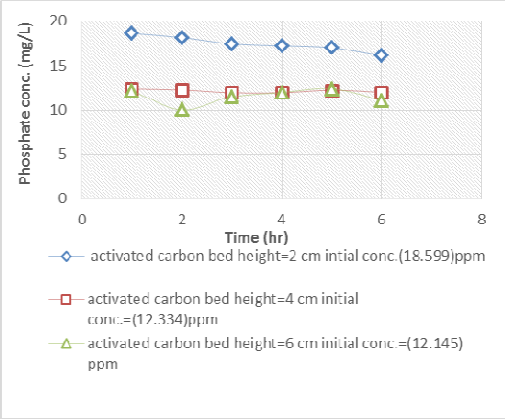

Figure (2): The effect of the activated carbon bed heights on the phosphate concentration at flow with in activated carbon =1 L/min, pH=8.2, Temp.=20^{0}C

Figure (2) indicates that the changing of the activated carbon bed height had no significant effect on the phosphate concentration that due that as the phosphate (nutrient) is a dissolved salt that not affect by the mechanism of the removal that offer by activated carbon (van-der-walls forces) also on phosphate radical is a strong combined components that cannot be splitted easily by a weak force.

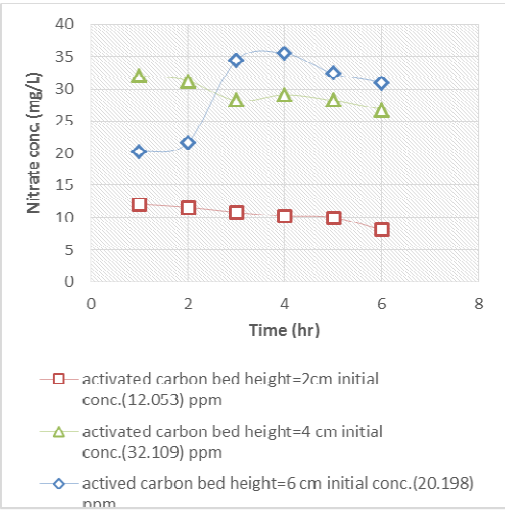

Figure (3): The effect of the activated carbon bed heights on the nitrate concentration at flow with in activated carbon =1 L/min, pH=8.2,Temp.=20^{0}C

From figure (3) it can be seen that the change in the activated carbon bed heights had no significant impact on the nitrate concentration that due to the weak attraction between the nitrate radicals and activated carbon that cannot be removed by the adsorption surface phenomena.

The parameters affecting the MBBR unit

1. The effect of MBBR weight: MBBR weights of (10,20,40,60) g were used to investigated of the influence of the changing this parameter on the (phosphate conc., nitrate conc.) respectively and the results presented as shown in the figures (4,5) by keeping all the other operational conditions constant.

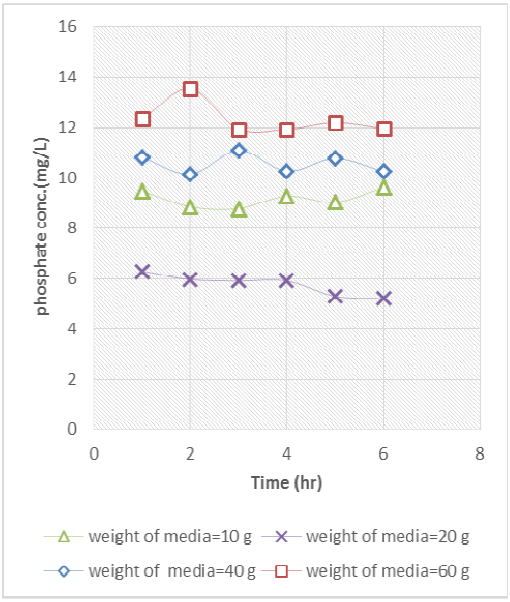

Figure (4): The effect of media weights on the phosphate concentration at flow of air=8m^3/h, flow of wastewater through MBBR=1 L/min, pH=7.8, specific surface area=4.71cm^2/cm^3,Temp.=20^{0}C, height of A.C=6 cm

A slight reduction of the phosphate concentration were noticed that reflect the minor influence of the media weight on the phosphate concentration that mean the critical operational conditions for phosphate removed not depending on the media weight.

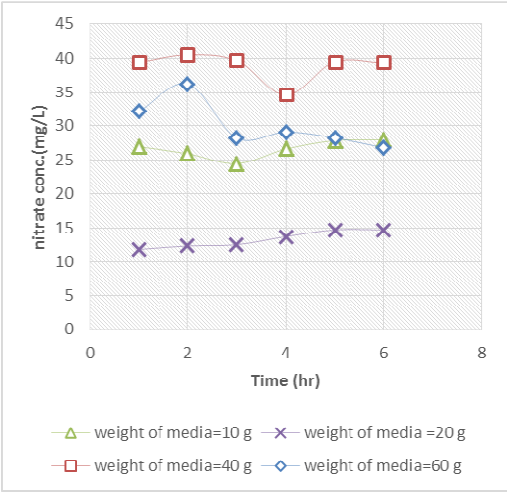

Figure (5): The effect of media weights on the nitrate concentration at flow of air=8m^3/h, flow of wastewater through MBBR =1 L/min, pH=7.8, specific surface area=4.71cm^2/cm^3,Temp.=20^{0}C, height of A.C=6 cm

From figure (5) reveals that no certain change occurs when the media weight was (10,20) g while increasing the media weight to (40,60) g reduce the nitrate concentration (especially 40 g).

2. The effect of air flow: Air flow rates of (4,6,8) m^3/h were used to investigated of the influence of the changing this parameter on the (phosphate conc., nitrate conc.) (figures 6,7).

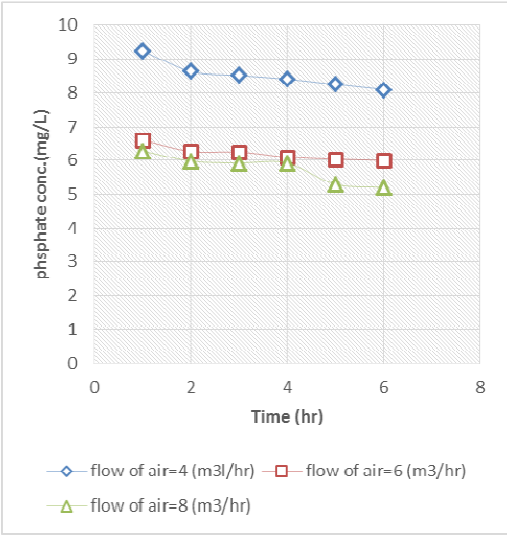

Figure (6): The effect of the air flows on the phosphate concentration at flow of wastewater through MBBR=1L/min, pH=7.63, specific surface area=4.71cm^2/cm^3,Temp.=20^{0}C, weight of media=20g, height of A.C=6cm

As can be seen from figure (6), a noticeable reduction in the phosphate concentration for all air flow ,increasing the air flow expected more reduction in the phosphate concentration ,as extra amount of air flow will give more chances for the aerobic bacteria to be more effectively to degrade the aerobic content.

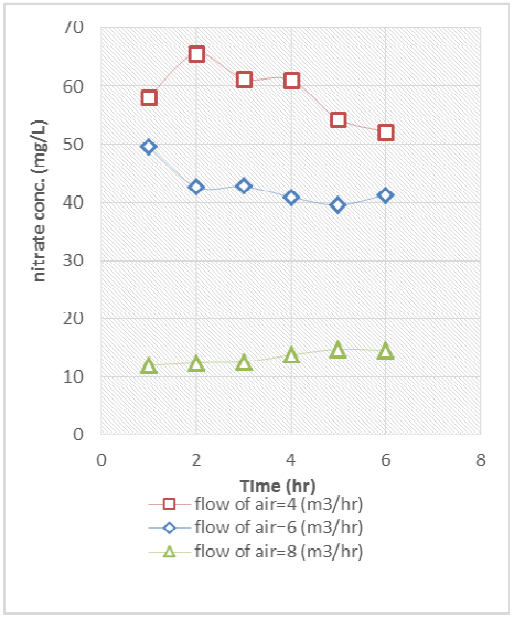

Figure (7): The effect of the air flows on the nitrate concentration at flow of wastewater through the MBBR=1L/min, pH=7.63, specific surface area=4.71cm^2/cm^3,Temp.=20^{0}C, weight of media=20g, height of A.C=6 cm

From figure (7) for an air flow of (6,8)m^3/h there is a slight change in the nitrate concentration that may due to certain air flow condition there will no change in the rate of the degradation process , at flow of air (4m^3/h) a noticeable decrease in the nitrate concentration was recorded that reflects the enhancement of the degradation process at certain value of air flow.

3. The effect of specific surface area: MBBR specific surface areas (4.71,3.768,2.45)cm^2/cm^{3}were used to investigated of the influence of the changing this parameter on the (phosphate conc., nitrate conc.) respectively and the results presented as shown in the figures (8,9) by keeping all the other operational conditions constant.

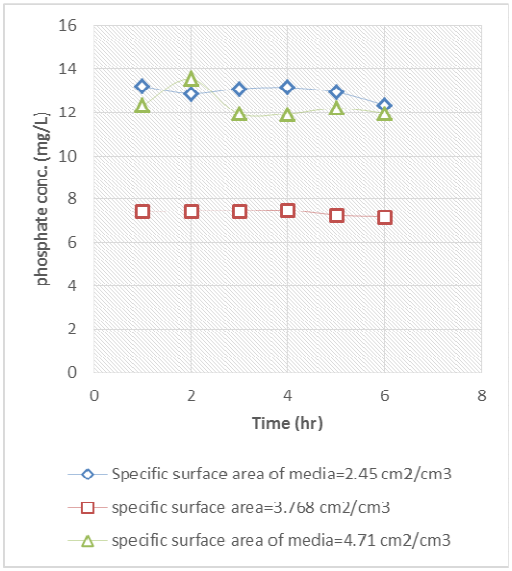

Figure (8): The effect of specific surface areas on the phosphate concentration at flow of air=8m^3/h, flow of wastewater through MBBR=1 L/min, pH=7.8, weight of media=60g Temp.=20^{0}C, height of A.C=6 cm

As a result of the increasing the specific surface area the degradation of phosphate increased due to the extra availability of the area ready to be attached by bacteria for degradation.

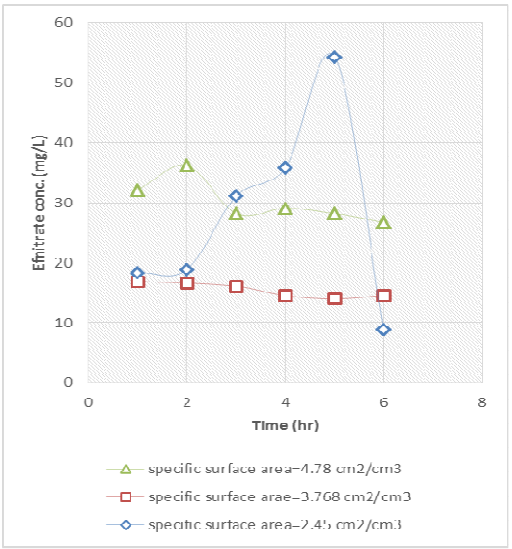

Figure (9): The effect of specific surface areas on the removal nitrate concentration at flow of air=8m^3/h, flow of wastewater through MBBR =1 L/min, pH=7.8, weight of media=60g Temp.=20^{0}C, height of A.C=4 cm

Investigated the figure indicates that the continuous reduction in the nitrate concentration with specific surface area.

4. The effect of the pH: pH of wastewater (4,8,12) was used to investigated of the influence of the changing this parameter on the (BOD,COD, ,TDS, phosphate conc., electrical conductivity , S.S, nitrate conc.) respectively and the results are tabulated in appendix (B) and presented as shown in the figures (10,11) by keeping all the other operational conditions constant.

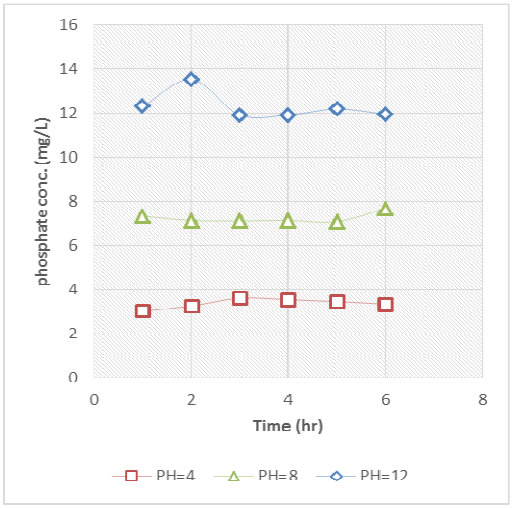

Figure (10): The effect of pH on the phosphate concentration at flow of air=8m^3/h, flow of wastewater through MBBR=1 L/min, weight of media=60g, specific surface area of media=4.71cm^2/cm^3,Temp.=20^{0}C, height of A.C=6 cm

No significant changes were noticed on the phosphate concentration as the pH varied (4,8,12) due to the high chemical stability of phosphate in differential pH environment.

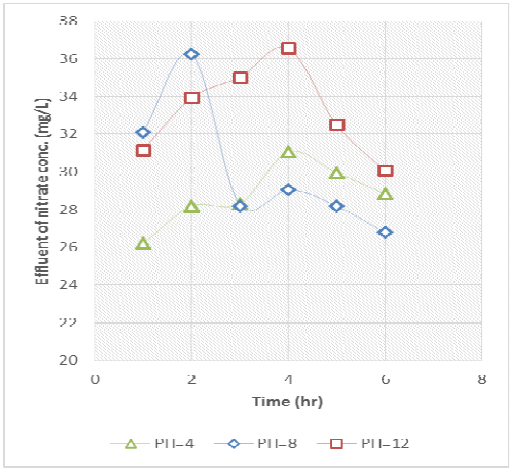

Figure (11): The effect of pH on the nitrate concentration at flow of air=8m^3/h, flow of wastewater through MBBR=1 L/min, weight of media=60g, specific surface area of media=4.71cm^2/cm^3,Temp.=20^{0}C, height of A.C=6 cm

The change in the pH values have a significant impact on the nitrate concentration as this will

enhancing the rate of degradation (activity of the bacteria for oxidize and degrade the nutrients).

5. The effect of the temperature: temp. of wastewater (10,20,350)^{0}C was used to investigated of the influence of the changing this parameter on the (phosphate conc., , nitrate conc.) respectively and the results presented as shown in the figure(12, 13) by keeping all the other operational conditions constant.

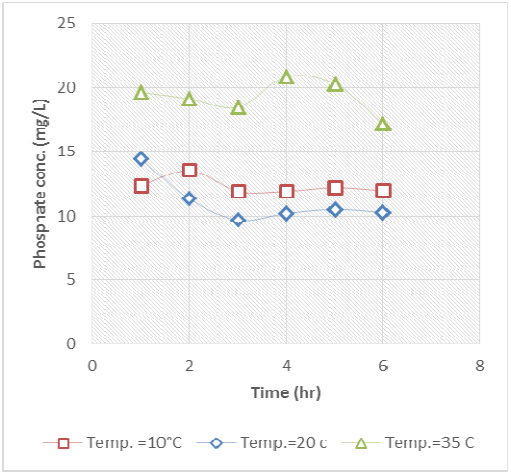

Figure (12): The effect of Temp. on the phosphate concentration at flow of air=8m^3/h, flow of wastewater through MBBR=1 L/min, weight of media=60g,pH=8, specific surface area of media=4.71cm^2/cm^3, , height of A.C=6 cm

Slight improvement in the reduction of phosphate concentration were measured that due additional activity will the bacteria attain as the temperature increased.

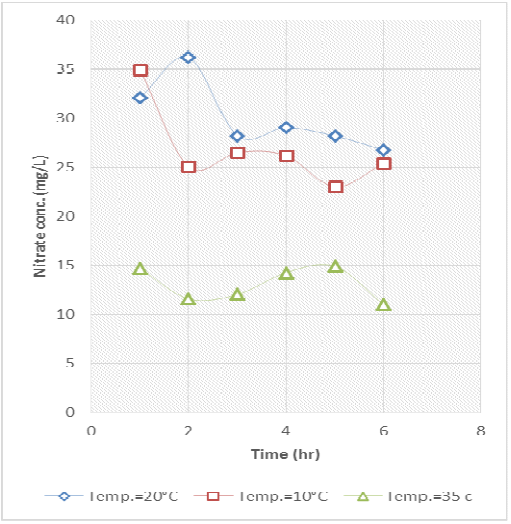

Figure (13): The effect of Temp. on the nitrate concentration at flow of air=8m^3/h, flow of wastewater through MBBR=1 L/min, weight of media=60g,pH=8, specific surface area of media=4.71cm^2/cm^3, , height of A.C=6 cm

As a temperature has a good enhancement for removal of nitrate for wastewater due to additional temperature will give an extra activity for the bacteria to degrade also will give more chance for a chemical degradation of nitrate.

CONCLUSION

In this research project, the MBBR carrier was evaluated in the context of overall process performance and potential future MBBR applications. The MBBR best performance was evaluated by the optimum operating condition. The hospital waste water was successfully treated from the phosphor and nitrate pollutants.

RECOMMENDATIONS

1. Encouraging recycling efforts, by giving incentives and tax exemptions where appropriate. Encourage public-private partnerships for instance giving licenses to private waste collectors.
2. Encouraging private sector to set up more recycling industries for recycling plastic and metallic solid waste. The private sector should also come up with strategies of reusing and conversion (composting) organic waste.
3. It is recommended that segregation for MSW should be carried out at the household level in terms of achieving highest efficiency for compost production.

NOMENCLATURE

EC= electrical conductivity
BOD = biological oxygen demand
COD = chemical oxygen demand
HDPE=high density poly ethylene.
LDPE=low density poly ethylene.

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Estimation of iron profile in patients with chronic renal diseases in Baghdad province

Zahraa I. Abudal Kadhum (1) Ahmed R. Abdulhameed (2) and Hayder A. Alnuimi (2)

(1) Dept. of Medical Laboratories Techniques /Al-Yarmouk University Collage (2) Dept. of Medical Laboratories Techniques /Al Israa University Collage

Republic of Iraq

E-mail: ijst.jordan@yahoo.com

ABSTRACT

Anemia is a frequent consequence of progressive renal disease. The results of iron level and transferrin obtained from the present study indicated that patients with (Iron profile in patients with chronic renal failure) had anemia, where serum iron and transferrin were low and the percentage of saturation of transferrin with iron was within the normal value.

The major factor underlying the development of anemia in patients with renal failure is a decrease in the levels of erythropoietin. Also it was reported that the retention of uremic toxins may shorten the half-life of red blood cells and diminish the response of the bone marrow to erythropoietin. In addition to other aggravating factors that contribute to the anemia of chronic renal failure which include bleeding, iron or other nutritional deficiencies, bone marrow fibrosis secondary to hyperparathyroidism, and aluminum excess. Some studies reported that increased losses of iron and transferrin in the urine may account for the iron deficiency anemia in patients with the nephrotic syndrome.

Keywords: renal , renal failure, anemia ,iron deficien***y***

INTRODUCTION

The kidneys are organs that serve several essential regulatory roles in most animals, including vertebrates and some invertebrates. They are essential in the system and also serve homeostatic functions such as the regulation of electrolytes, maintenance of acid–base balance, and regulation of blood pressure (via maintaining salt and water balance). The kidneys also produce hormones including
calcitriol, erythropoietin, and the enzyme renin (1-3), The term "renal failure" means failures of renal excretory function owing to depression of the glomerular filtration rate (4). It can occur abruptly, as in acute renal failure (ARF), or over a long period, as in chronic renal failure (CRF) (5). CRF is defined as progressive and irreversible loss of renal function (6). It is a major public health problem, with increasing incidence and prevalence, poor outcomes, and high costs (6,7). CRF frequently leads to end stage renal disease (ESRD), which without renal replacement therapy would lead to death (5,8,9). Iron is an essential nutrient required by every human cell (10). Its atomic structure gives rise to a number of biochemically useful properties, including the unusual capacity to both donate and accept electrons, and to reversibly bind to ligands such as oxygen and nitrogen (11). Anemia of chronic illness traditionally encompassed any inflammatory, infectious, or malignant disease of a long-standing nature. The modern definition includes rheumatoid arthritis, severe trauma and heart disease. The incidence of renal disease is more common in males than in females, in black than in white, and is increased with age (12,13). Cigarette smoking has also been linked with the development of chronic kidney disease, as has dyslipidemia (14-17) and elevated homocystein levels (18). Hypertension and proteinuria occur in most patients with chronic kidney disease and are risk factors for faster progression of this disease (19). Another proposed mechanism for anemia of chronic illness deals with cytokines, such as interleukins (IL-1 and IL-6), and tumor necrosis factor (TNF-alpha), which are believed to cause the destruction of RBC precursors and decrease the number of erythropoietin receptors on progenitor cells (19-21).

MATERIALS AND METHODS

Consecutive patients admitted to Ghazi and Baghdad Teaching Hospital with renal dysfunction symptoms were studied. The study group which included 27 patients was assessed by clinical examination.
Most of Patients that included in the present study were females 14 (56 %) with mean age value of (35) years, while the number of males The study parameters included Glucose, Total Cholesterol, HDL- Cholesterol**,** Triglyceride Level, blood urea and serum creatinine, uric acid and Hematological test.

RESULTS AND DISCUSSION

Although decreased RBC production is the main mechanism in both anemia of chronic illness and anemia o chronic kidney disease. Oftentimes. the anemia is due to a combination often things. Including concomitant blood loss. There are at reticulocyte count should always be interpreted with caution. Measurement of serum erythropoietin levels is of no current diagnostic utility in patients with chronic kidney disease, as it is expected to be low. Neither does it influence the starting dose or any adjustment in dosing of erythropoiesis-stimulating agents (ESAs) in such patients; these agents may have some use, however, in patients with anemia secondary to chronic illness. In addition, regression of left ventricular hypertrophy (Lvl-t) is a known- benefit or initiation of treatment with ESAs (table 1).

Table (1): Mean values of sera fast blood glucose, urea, uric acid, concentrations of control and patients with chronic renal diseases

No. of cases	F.B.G (mg/dL)±SD	U.A (mg/L)±SD	B.U (mg/L)±SD
Patient (27)	(42.8-284) 119 ± 34	(3.6-9.2) 7.8 ±2.28	(10-152) 35.3 ± 24
Control (20)	80.5 (65-110)	4.46 (3-7)	28.5 (20-45)
P-Value	P≥0.05	P≥0.05	P≥0.05

Reticulocyte count

In the clinical approach to a patient with anemia. Aside from reviewing the RHF indices and the peripheral smear. Another important lcs l is the rcticulocyte count. Reticulocyte count usually points to decreased RBC production as the primary mechanism responsible for anemia, whereas an elevated reticulocyte count points for increased RBC destruction or hemolysis as the most likely cause (tables 2 and 3).

Table (2): The comparison of complete blood film result in chronic renal disease patients and Healthy control

	RBC (10^6/ul)±SD	HGB (G/dl)±SD	MCV (Fl)±SD	MCH (pg)±SD	MCHC (g/DL)±SD	RDW (%)±SD
Patient (27)	(2.35-6.28) 4.3± 0.86	(6.53-17.4) 11.1±3.7	(66.3-91.4) 80.6±23.1	18.6-30.2 25.8± 16.8	(28.1-33.3) 31.8±16.9	(11.2-15.8) 13.5±2.3
Control (20)	6.00 (4.00-6.00)	14.5 (12-17)	88.55 (81.1-96.0)	30.5 27.0-34.0	26 11.5-14.5	13.5 11.2-15.8
P-Value	P≥0.05	P≥0.05	P≥0.05	P≤0.05	P≥0.05	P≤0.05

Table (3): Mean values of sera P.C.V, Hb., ESR concentrations of control and patients with chronic renal disease

	P.C.V (gm/dl)±SD	Hb. (g/dl)±SD	ESR (mm/hr) ±SD
Patient (27)	(16-49) 36.2±4.3	(6.53-17.4) 11.1±3.7	(10-39) 19.5± 2.3
Control (20)	47 (41-53)	14.5 (12-17)	13.6 (19-20)
P-Value	P≥0.05	P≥0.05	P≥0.05

CONCLUSION

This study has focused on chronic renal failure (CRF) and its relation with anemia. This disease is a major public health problem, with increasing incidence and prevalence, poor outcomes, and high costs CRF frequently leads to end stage renal disease (ESRD), which without renal replacement therapy would lead to death. The study was conducted on 25 serum samples from patients with CRF whose admitted to Ghazi & Baghdad Teaching Hospital with renal dysfunction symptoms, aged 20-65 years, most of patients that included in the present study were females 14 (56 %) with mean age value of (35) years, while the number of males were 11(44 %) with mean age value of (36) years. As a control group 20 healthy individuals were used in this study including 11 (55 %) men with mean age value of (31 years) and 9 (45 %) women with mean age value of (33).

Evaluation of each patient is done by:

1- Determining fasting blood sugar, serum albumin, blood urea, and uric acid levels.
2- Determining complete blood pictures, packed cell volume (P.C.V.), Hemoglobin concentration, and erythrocyte sedimentation rate (E.S.R).

The results indicate the following:

1. Significant decreases ($p<0.005$) in serum cholesterol mean value , and the average amount (mass) of haemoglobin in red blood cells(MCH) of patients group in comparisons to control group.
2. Significant increases ($p<0.005$) in erythrocyte sedimentation rate (E.S.R) of patients group in comparisons to control group.

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Knowledge assessment of infection control among specialist and general practitioner dentists in Mosul

Mahdi Mahmood Saleh and Atyaf Ghazi Mahmood

Al-Noor Specialist Health Center of Dentistry / Al- Mosul
Republic of Iraq

ABSTRACT

Infection control is an important issue in dentistry, as dentists are primarily responsible for observing the appropriate procedures. Objective to assess the knowledge of the specialist and general practitioner dentist's population in specialized health center of dentistry in Mosul regarding the infection control. A questionnaire-based study was conducted among 60 specialist dentists and 40 general practitioner dentists in specialized health center of dentistry in Mosul, a questionnaire was a field, and the answer was completed and subjected to analysis. These questions are summarized from the Guideline for Infection Control in Dental Health Care Setting, Practical Guideline for Infection Control in Health Care Facilities, and Guideline for Hand Hygiene in Health Care Settings. The result, of the knowledge of specialist dentist about the record of medical history is needed was 96.7%, while the knowledge of general practitioner (GP) was 100%. The quest specialist thought the washing hand is necessary before wearing gloves for examination (93.3%) and 30% after examination of the patient, and for the general practitioner the result was 75%, and 100% respectively. Most of the specialist dentist (98.3%) believe that the plan soap is an effective item in infection control, while only 25% of the GP believes the plan soap is effective. In this study, most of our quests specialist and GP with the gloves and mask prevents the infection to health care personnel and to the patient. All the specialist dentists with the face mask should be changed between the patient and 75% of GP with that item. 83.3% of specialist dentists deem the use of an autoclave is an effective way of sterilization and all the GP deem the sterilization by autoclave is an effective way. About the following require disinfection; dental chair with its accessories, handpiece, burs, impression after rinsing it under water, and x-ray device with its accessories the specialist knowledge was 75%, 75%, 41.7%, 58.3%, and 91.7% respectively, while the GP knowledge was 80%, 82.5%, 82.5%, 55%, and 62.5% respectively. All quested specialist deem all materials transported to and from dental laboratory must be cleaned, and 65% of GP thought that only. Most of the specialist and GP believe that the special container should be used for a disposable medical category of waste. All specialist participants and most of the GP thought that the all health care personnel should be vaccinated for communicable disease regularly. This study concluded that the knowledge of specialist and general practitioner dentists in Mosul about the infection control guideline was good and this knowledge need to apply in the dental clinic to provide health and safety environment for dental staff and patients.

Keywords: Knowledge, infection control, specialist dentists, study

INTRODUCTION

The dental unit and the associated treatments provide a rich source of the microbial environment, establishing an equal chance for everyone at the dental office to contract the infection (1).

Infection continues to be one of the most critical issues in health care service worldwide. Infection prevention and control of cross-contamination are essential in providing a secure environment for patient and healthcare workers within a healthcare setting in general and more specifically in dental practices (2).

Using safety precaution and implementing infection control guideline along vaccination and proper post-exposure management can prevent infection (3).

Although many guidelines and recommendation are issued by medical and dental societies as well as governmental organization, studies illustrated that infection is not well controlled in some dental practice and hospitals (4).

Despite the considerable emphasis placed on standard infection control procedures, it appeared that only a few dentists adhered to these protocols in their dental practice (5,6). Therefore the study was planned to assess the knowledge of infection control among specialist dentist and general practitioner dentist in specialized health center of dentistry in Mosul, Iraq.

MATERIALS AND METHODS

A questionnaire-based study was conducted to assess knowledge in an infection control among specialist and general practitioner dentist's population in a specialized health center of dentistry, Mosul during July 2018. The sample comprised of 60 specialist dentists and 40 general practitioner dentists. The study was approved by the research ethical and scientific committee of Nineveh health directorate, Iraq. After obtaining approval from the institution, a questionnaire comprising of 11 self-administered close-ended questions was distributed to the dentists who were available on the day of the survey. These questions are summarized from Guideline for Infection Control in Dental Health Care Setting (7), Practical Guideline for Infection Control in Health Care Facilities (8), and Guideline for Hand Hygiene in Health Care Settings (9). Junior dentists and dental assistants were excluded from the study. The questionnaire is described in table (1).

Table(1): Questions for Assessment of the Knowledge of dentists in an infection control in dentistry

Q. No.	Questions	
1	Record of previous medical history is needed. yes no	
2	Washing hands is necessary	
	a)	Before wearing gloves for examination yes no
	b)	After examining a patient yes no
3	The Plain soap is an effective item in infection control yes no	
4	Gloves and mask prevents infection to health care provider yes no	
5	Gloves and mask prevents infection to the patient yes no	
6	The face mask should be changed between patients yes no	
7	Use of autoclave effective way of sterilization?	
8	The following requires disinfection	
	a	Dental chair and its accessory yes no
	b	Handpiece yes no
	c	Burs yes no
	--------	----------
	d	After Rinsing impression under water yes no
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	e	x-ray devise and its accessory yes no
9	All material transported to and from dental laboratory must first be cleaned yes no	
10	The special container should be used for a disposable medical category of waste yes no	
11	All health care personnel should be vaccinated for communicable diseases regularly yes no	

RESULTS

A total of 100 dentists participated in this study, 60 of them was specialist and 40 was a general practitioner. All of them in the specialized health centers of dentistry in Nineveh health directorate. The filled questionnaire was collected from dentists and the data were entered into the social package of statistical science version 16 for windows. Descriptive data that include frequency and percentage were calculated and computed for variable knowledge. Results about knowledge of specialist dentists toward the infection control were in table (2), and for general practitioner dentists in table (3). The T-Test between Specialist and general practitioner, there is no significant difference between them as shown in the tables (4, 5).

Table (2): The distribution of participant's specialist according to their response of the questionnaire, the frequency, and percentage for each item

No.	item	yes	Percent%	no	Percent%
1	Record of previous medical history is needed.	58	96.7	2	3.3
2	washing hands is necessary				
a	before wearing gloves for examination	56	93.3	4	6.7
b	after examining a patient	18	30.0	42	70.0
3	the plan soap is effective item in infection control	59	98.3	1	1.7
4	gloves and mask prevents infection to health care provider	54	90.0	6	10.0
5	gloves and mask prevents infection in the patient	58	96.7	2	3.3
6	face mask should be changed between patients	60	100.0	0	0.0
7	use of autoclave effective way of sterilization	50	83.3	10	16.7
8	the following requires disinfection				
a	dental chair and its accessory	45	75.0	15	25.0
b	hand piece	45	75.0	15	25.0
c	burs	25	41.7	35	58.3
d	after rinsing impression under water	35	58.3	25	41.7
e	x-ray device and its accessory	55	91.7	5	8.3
9	all material transported to and from dental laboratory must first be cleaned	60	100.0	0	0.0
10	the special container should be used for disposal medical category of waste	58	96.7	2	3.3
11	all health care personnel should be vaccinated for communicable diseases regularly	60	100.0	0	0.0

Table (3) Explain distribution of the participant's general practitioner according to their response of the questionnaire, the frequency, and percentage for each item

No.	item	yes	percent%	no	percent%
1	Record of previous medical history is needed.	40	100	0	0
2	washing hands is necessary				
a	before wearing gloves for examination	30	75	10	25
b	after examining a patient	40	100	0	0
3	the plan soap is an effective item in infection control	10	25	30	75
4	gloves and mask prevents infection to health care provider	38	95	2	5
5	gloves and mask prevents infection in the patient	38	95	2	5
6	the face mask should be changed between patients	30	75	10	25
7	use of autoclave effective way of sterilization	40	100	0	0
8	the following requires disinfection				
a	dental chair and its accessory	32	80	8	20
b	hand piece	33	82.5	7	17.5
c	burs	25	62.5	15	37.5

d	after rinsing impression under water	22	55	18	45
e	x-ray device and its accessory	25	62.5	15	37.5
9	All material transported to and from dental laboratory must first be cleaned	26	65	14	35
10	The special container should be used for disposal medical category of waste	39	97.5	1	2.5
11	All health care personnel should be vaccinated for communicable diseases regularly	38	95	2	5

Table (4): Group Statistics (The T-Test between Specialist and G.P.)

	VAR00007	N	Mean	Std. Deviation	Std. Error Mean
S	1	15	0.8262	0.19509	0.05037
GP	2	15	0.8367	0.21231	0.05482

Table (5): Independent Samples Test (The T-Test between Specialist and G.P)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
S	Equal variances assumed	0.067	0.798	-0.141-	28	0.889	-0.01047-	0.07445	-0.16296-	0.14203
GP	Equal variances not assumed			-0.141-	27.802	0.889	-0.01047-	0.07445	-0.16301-	0.14208

The T-Test between Specialist and G.P., there is no significant different between them

DISCUSSION

In this study the knowledge of specialist dentist about record of medical history is needed was 96.7%, while the knowledge of general practitioner was 100%, this rate is high and similar finding was present, more than ninety percent of subjects always take medical history in study performed in India (10).

The quest specialist thought the washing hand is necessary before wearing gloves for examination (93.3%) and 30% after examination of patient, and for the general practitioner the result was 75%, and 100% respectively, while a study in Makkah show the performing hand hygiene after removing gloves was 88.5% for specialist and 75.3% for general practitioner (11). The low rate of specialist knowledge about washing hand after examination of the patient due to lack in the recommendation of infection control guideline.

Most of the specialist dentists (98.3%) believe that the plan soap is effective item in infection control, while only 25% of the general practitioner believe the plan soap is effective. Other studies showed that the most participants use soap for hand washing (12). The general practitioner may think that because the plan soap not contain antimicrobial agent.

In the present study, most of our quest's specialists and general practitioners understood that the gloves and mask prevent the infection to health care personnel and to the patient, which consider a significantly higher percentage toward the infection control recommendation.

All the specialist dentists with the face mask should be changed between the patient and 75% of general practitioner with that item, that indicate the high knowledge of our participants regarding infection control recommendation in relation to other study carried in Pakistan the changing of face mask between the patients was 48.3% of responders (13).

A percentage of 83.3% of specialist dentists deem the use of an autoclave is an effective way of sterilization and all the general practitioner deem the sterilization by autoclave is an effective way that comes with the agreement of study carried in India community (1).

About the following require disinfection; dental chair with its accessories, handpiece, burs, impression after rinsing it under water, and x-ray device with its accessories the specialist knowledge was 75%, 75%, 41.7%, 58.3%, and 91.7% respectively, while the general practitioner knowledge was 80%, 82.5%, 82.5%, 55%, and 62.5% respectively. A study done in Dow International Dental College the result about

disinfection of dental chair was 91.3% (14), and a study performed on Turkish dentist about disinfection of handpiece was 80%, and for dental radiograph equipment was 18.5% (15), and a study in kingdom of Saudi Arabia about rinsing the impression under the water after being removed from the patient's mouth was 96.5% (16).

All quested specialists deem all materials transported to and from dental laboratory must be cleaned, and 65% of general practitioner thought that only. A study in the kingdom of Saudi Arabia about regular disinfection of dental cast, denture prosthesis, and metal framework for removable or fixed prosthesis was 17.8%, 68.8%, and 68.8% respectively (16).

Most of the specialists and general practitioners believe that the special container should be used for a disposable medical category of waste, this rate is high in relation to study in Saudi Arabia that was 20% (17), our responders having good information regarding infection control.

Because of their contact with patients or infective material from patients, many healthcare personnel is at risk of exposure to (and possible transmission of) vaccine-preventable diseases. Employers and healthcare personnel have a shared responsibility to prevent occupationally acquired infections and avoid causing harm to patients by taking reasonable precautions to prevent the transmission of vaccine-preventable diseases (18).

All specialist participants and most of the general practitioner thought that all health care personnel should be vaccinated for communicable disease regularly come in agreement with that recommendation.

The selection of the item is one of the biggest challenges when structuring questionnaires.

CONCLUSION

The outcomes of this study were good about the knowledge regarding infection control among specialist and general practitioner dentists and this knowledge need to applied in the dental clinic to provide health and safety region for dental staff and patients.

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Knowledge assessment of infection control among junior dentists in Mosul

Mahdi Mahmood Saleh and Atyaf Ghazi Mahmood

Al-Noor Specialist Health Center of Dentistry / Al- Mosul
Republic of Iraq

ABSTRACT

Dentists are in general are more susceptible to contracting infectious diseases while providing patient care if they do not follow proper infection control techniques. The aim of the current study was to **assess** the knowledge of infection control among the junior dentist's population in specialized health center of dentistry in Mosul. Across a sectional survey conducted on 140 junior dentists in specialized health centers of dentistry in Mosul, the questionnaire was answered and the answers were collected and subjected to analysis. The templet of the questionnaire was summarized from Australian Dental Association's Guideline for Infection Control, the results of this study show that junior dentist knowledge was 96.4% about record of previous medical is needed and 64.3%, 85.7% respectively about washing hands is necessary before wearing the gloves for examination and after examination a patient, while the effectiveness of plan soap in infection control is 32.1%, and 82.1% about the effect of gown, aprons, and eye protection as a guard from the splashes, spray of blood and body fluid. Gloves and mask prevent infection to health care provider was 57.9% and 78.6% prevent infection to the patient, changes are warranted after each patient was 57.1%, and a face mask should be changed between patient was 60.7%. The effective way of sterilization by using autoclave is 100% while using disinfecting solution was 57.1%, the following require disinfection; dental chair and its accessory, hand piece, burs, shade guide, after rinsing impression under water, x-ray device and its accessory, and x-ray apron was 64.3%,71.4%, 78.6%, 61.4%, 50%, 59.3%, and 65.7% respectively. All material transported to and from dental laboratory must first be cleaned was 55%, and 75% for a special container that should be used for a disposable medical category of waste. About the wall, floor and carpets should be cleaned regularly the result was 84.3%, while 89.3% for all health care persons should be vaccinated for communicable disease regularly and 87.9% was for the infection can transmit in the dental clinic (HIV, HBV, HCV, HHV, and TB). This study concluded that the knowledge of junior dentists in Mosul about the infection control guideline is low, need more attention, education, and follow up from Iraqi Ministry of Health /Environment and Iraqi Dental Association to overcome the defect in the information of dentist regarding infection control.

Keywords: Knowledge, infection control, junior dentists, study

INTRODUCTION

Oral health care workers are particularly exposed to infectious material in the course of their routine service. The risk of infections varies from the innocuous common cold to life-threatening diseases such as tuberculosis, hepatitis and HIV/AIDS (1,2). The human mouth is a fertile environment for the transmission, inoculation, and growth of various infectious and detrimental microorganisms (3). Blood and saliva are the common routes for transmission of such microbial agents in the dental operatory (4). Transmission can be through direct contact with blood, saliva, and other secretions or indirect contact with contaminated instruments, equipment, and environmental surfaces or contact with airborne contaminants (5).

It has been demonstrated experimentally that dental equipment can retain infectious agents unless thoroughly cleaned before sterilization (6). A number of infection control guidelines now exist for use in dental practice which is aimed at minimizing the risks of cross-contamination (7).

There are many guidelines for infection control according to school of dentistry in that community, by this way we conduct our research to explain the junior dentist education in this field in our community according to Australian Dental Association's Guideline for Infection Control (8). Guideline for Infection Control in Dental Health Care Setting (9). Summary of Infection Prevention Practices in Dental settings (10) Practical Guideline for Infection Control in Health Care Facilities (11), and Guideline for Hand Hygiene in Health Care Settings (12).

Although several suggestions have been made by medical and dental societies as well as governmental organizations, studies disclose that infection is not well controlled in dental settings (13).

Therefore the objective of this study was focused on the junior dentist to assess their knowledge regarding the infection control.so as to assess if any additional attention in this aspect is required, specialized health center of dentistry, Mosul.

MATERIALS AND METHODS

A questionnaire-based study was conducted to asses' knowledge in an infection control among junior dentists' population in specialized health centers of dentistry, Mosul in July 2018. We summarized 15 questions from Australian Dental Association's Guideline for Infection Control, Guideline for Infection Control in Dental Health Care Setting, Summary of Infection Prevention Practices in Dental Setting, Practical Guideline for Infection Control in Health Care Facilities, and Guideline for Hand Hygiene in Health Care Settings. The sample comprised of 140 junior dentists. The study was approved by the research ethical and scientific committee of Nineveh health directorate, Iraq. After obtaining approval from the institution, a questionnaire comprising of 15 self-administered close-ended questions was distributed to the junior dentists who were available on the day of the survey. Specialist dentist, general practice dentist, and dental assistants were excluded from the study. The questionnaire is shown in the table (1).

Table (1): Questions for Assessment of the Knowledge of dentists in an infection control in dentistry

Q. No.	Questions	
1	Record of previous medical history is needed. yes no	
2	Washing hands is necessary	
	a)	Before wearing gloves for examination yes no
	b)	After examining a patient yes no
3	The Plain soap is an effective item in infection control yes no	
4	Gowns/ aprons and eye protection guards from the splashes, sprays of blood and body fluids yes no	
5	Gloves and mask prevents infection to health care provider yes no	
6	Gloves and mask prevents infection to the patient yes no	
7	Change of gloves is warranted after each patient yes no	
8	The face mask should be changed between patients yes no	
9	An effective way of sterilization?	
	a)	Use of autoclave yes no
	b)	Disinfecting solutions yes no
10	The following requires disinfection	
	1	Dental chair and its accessory yes no
	2	Handpiece yes no

	3	Burs yes no
	4	Shade guide yes no
	5	After Rinsing impression under water yes no
	6	x-ray device and its accessory yes no
	7	x-ray apron yes no
11	All material transported to and from dental laboratory must first be cleaned yes no	
12	The special container should be used for disposal medical category of waste yes no	
13	Wall, floor, carpets should be cleaned regularly yes no	
14	All health care personnel should be vaccinated for communicable diseases regularly yes no	
15	Infections can be transmitted in the dental clinic (HIV, HBV, HCV, HERPS VIRUS and TB) yes no	

RESULTS

A total of 140 junior dentists participated in this study. All of them in the specialized health centers of dentistry in Nineveh health directorate. The filled questionnaire was collected from junior dentists and the data were entered into the social package of statistical science version 16 for windows. Descriptive data that include arithmetic mean, frequency and percentage were calculated and computed for variable knowledge as in table (2) and figure (1). Results about knowledge of junior dentists toward the infection control were in figure (2).

The results of this study show that junior dentist knowledge was 96.4% about record of previous medical is needed and 64.3%, 85.7% respectively about washing hands is necessary before wearing the gloves for examination and after examination a patient, while the effectiveness of plan soap in infection control is 32.1%, and 82.1% about the effect of gown, aprons, and eye protection as a guards from the splashes, spray of blood and body fluid. Gloves and mask prevent infection to health care provider was 57.9% and 78.6% prevent infection to the patient, changes are warranted after each patient was 57.1%, and a face mask should be changed between patient was 60.7%. The effective way of sterilization by using autoclave is 100% while using disinfecting solution was 57.1%, the following require disinfection; dental chair and its accessory, handpiece, burs, shade guide, after rinsing impression under water, x-ray device and its accessory, and x-ray apron was 64.3%,71.4%, 78.6%, 61.4%, 50%, 59.3%, and 65.7% respectively. All material transported to and from dental laboratory must first be cleaned was 55%, and 75% for a special container that should be used for a disposable medical category of waste. About the wall, floor and carpets should be cleaned regularly the result was 84.3%, while 89.3% for all health care persons should be vaccinated for communicable disease regularly and 87.9% was for the infection can transmit in the dental clinic (HIV, HBV, HCV, HHV, and TB).

Table (2): The distribution of the participants according to their answer of questions (frequency and percentage for each item)

No.	item	YES	percent%	NO	percent%
1	Record of previous medical history is needed.	135	96.4	5	3.6
2	washing hands is necessary				
a	before wearing gloves for examination	90	64.3	50	35.7
b	after examining a patient	120	85.7	20	14.3
3	the plan soap is effective item in infection control	45	32.1	95	67.9
4	gowns/aprons and eye protection guards from the splashes, sprays of blood and body fluids	115	82.1	25	17.9
5	gloves and mask prevents infection to health care provider	81	57.9	59	42.1
6	gloves and mask prevents infection in the patient	110	78.6	30	21.4
7	change of gloves is warranted after each patient	80	57.1	60	42.9
8	the face mask should be changed between patients	85	60.7	55	39.3
9	an effective way of sterilization				
a	use of autoclave	140	100.0	0	0.0
b	disinfecting solutions	80	57.1	60	42.9

10	the following requires disinfection				
a	dental chair and its accessory	90	64.3	50	35.7
b	hand piece	100	71.4	40	28.6
c	burs	110	78.6	30	21.4
d	shade guide	86	61.4	54	38.6
e	after rinsing impression under water	70	50.0	70	50.0
f	x-ray device and its accessory	83	59.3	57	40.7
g	x-ray apron	92	65.7	48	34.3
11	all material transported to and from dental laboratory must first be cleaned	77	55.0	63	45.0
12	the special container should be used for disposal medical category of waste	105	75.0	35	25.0
13	wall, floor, carpets should be cleaned regularly	118	84.3	22	15.7
14	all health care personnel should be vaccinated for communicable diseases regularly	125	89.3	15	10.7
15	infections can transmitted in dental clinic(HIV,HBV,HCV,HERPS VIRUS and TB)	123	87.9	17	12.1

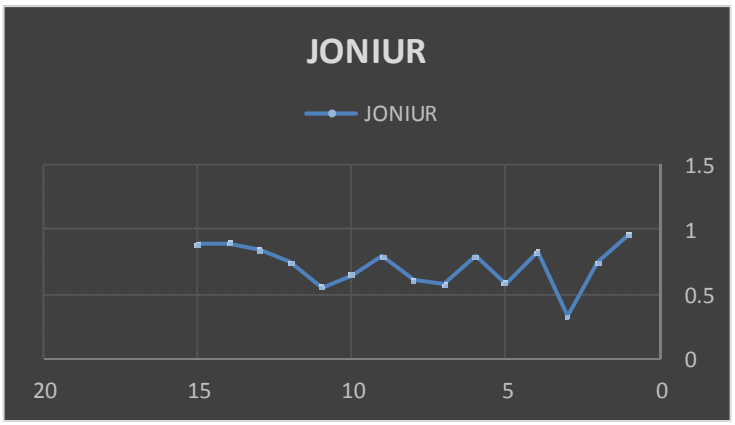

Figure (1): diagram shows the mean of questions

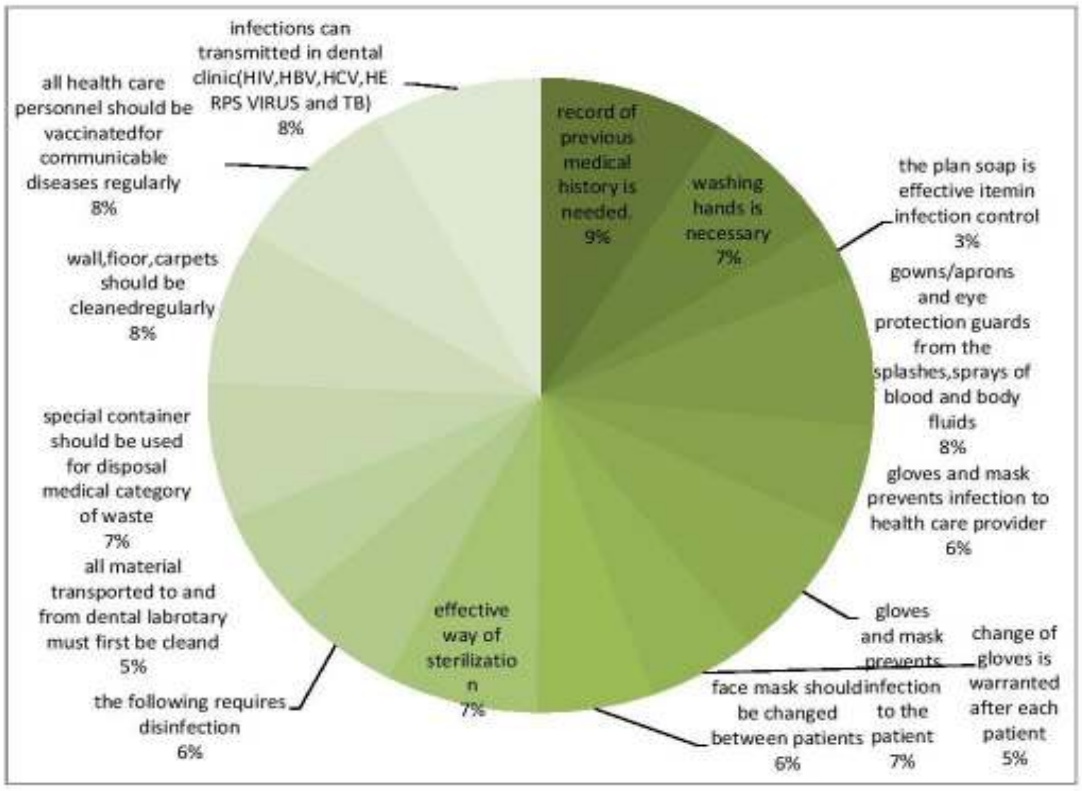

Figure (2): The degree of knowledge of participants

DISCUSSION

The results of the present study reveal the junior dentist's knowledge toward the infection control at specialized health centers of dentistry in Mosul city. In this study most, junior dentist with taking a medical history from the patient (96.4 %), almost near the result of a study done in Pakistan community which was 98.3% (14), these results are with the agreement of importance of medical history taking.

Participants thought that the washing hands is necessary before wearing a gloves for examination was 64.4% and after examination was 85.7%, whereas a study in India community the result was 95.5% (15). In our community that result considered low in comparison with indication for hand hygiene that includes contact with patient skin, contact with environment surface in the immediate vicinity of patient, and after glove removal (12).

Hand hygiene can perform either rub with an alcohol-based hand rub or by washing with soap and water (16). Only 32.1 % of junior dentists thought that the plan soap is effective in infection control that means there is disagreement with that recommendation and a study in Saudi Arabia show only 47.9% (male) and 30.6% (female) washing hands with soap after contact with bloody saliva (17).

A percentage of 82.1% of junior dentists believed that the gown/apron and eye protection guard from the splash and sprays of blood or body fluids, in a national survey of Canadian dentist, only 70% use that equipment as a basic barrier (18). Our result comes with the agreement of the Center of disease control recommendation, especially when using high-speed rotary instrument which splash blood and saliva all around (19).

Only 57.9% of participants in this study thought that the gloves and mask prevent the infection to health care provider, while 78.6% thought, prevents the infection to the patient. A study in India show that all quested thought that gloves and mask prevent infection to health care provider, and 82.5% believed that they also prevent infection to the patient (20) and that means there is disagreement in the result of that and our community.

In this study, the knowledge of junior dentists about the changes of gloves is warranted after each patient was 57.1%, which disagreement with the study done in Pakistan community which was 98.3% of their participant's changes glove after each patient (14). Inappropriate use of glove could lead to the spread of microorganism and potentially put the caregiver at increased risk (21).

Although the importance of facemask wearing during a dental procedure in an infection control our quested thought about the changing of the mask between patients was 60.7% while a study in Saudi

Arabia the result was 7.6% the quested change the mask between patients (22).

All respondents believed that the effective way of the autoclave in sterilization, while 57.1% thought the effective way of the disinfected solution in sterilization, although there is a difference between sterilization and disinfection.

This study shows that the following require disinfection; dental chair and its accessories, handpiece, bur, shade guide, after rinsing of impression under water, x-ray device and its accessories and x-ray apron was 64.3%, 71.4%, 78.6%, 61.4%, 50%, 59.3%, and 65.7% respectively which agreement with a study carried in clinic in kingdom of Saudi Arabia community in which 53.5%-79.1% of the subjects were aware of disinfecting importance items used regularly (23). Burns consider critical item and must be sterilized, while the other items considered non-critical and can be cleaned alone with detergent and water (is sufficient) (8).

The knowledge of quest about materials transported to and from dental laboratory must be first cleaned was 55%. Another study conducted show disinfecting the following items was dental cast 14.4%, denture prosthesis 87.2%, and removable or fixed prosthesis after trying in 72.8 % (3).

In this study, quested knowledge about special container should be used for a disposable medical category of waste was 75% similar finding have been reported (20).

A percentage of 84.4% of participants thought that the wall, floor, and carpets should be cleaned regularly, while floor, wall, and curtains pose minimal risk of disease transmission in the dental clinic. Nevertheless, these surfaces mentioned in a clean hygiene condition (8).

All unvaccinated persons whose work and training related activities involve reasonably anticipated risk for exposure to blood or other infectious body fluid should be vaccinated (24). In our community, only 89.3% of quested believed vaccination is important that comes with the agreement of study carried in Saudi Arabia which was 76.5% of respondents consider the vaccination is important (25).

87.9% of junior dentist believed the infection as (HIV, HBV, HCV, HHV, and TB) can be transmitted in the dental clinic. All diseases mentioned above are infectious diseases and can be transmitted through dental work.

Not all infection control procedure was listed in questionnaire because of concerns that increase the number of questions would reduce the accuracy of response and response rate.

CONCLUSION

Knowledge of junior dentists in Mosul about the infection control guideline is low, need more attention, education, and follow up from Iraqi Ministry of Health /Environment and Iraqi Dental Association to overcome the defect in the information of dentist regarding infection control. This research was applied to became as a base for building a new guideline for Iraqi dental association and enhance advance infection control program among new dentist inter the specialist field.

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Physical and chemical analysis of spring water quality in some villages in Barware Sheree district, Kurdistan region, Iraq

Ansam A. S. Al-Hamdany (1) and Musher R.A. Al- Barwary (2)

(1) Dept. of Environmental Sciences / College of Environmental sciences and Technology/ University of Mosul (2) Dept. of Environmental Sciences/ College of Sciences/ University of Zakho
Republic of Iraq

E –mail: ahmedansam@gmail.com

ABSTRACT

Spring water is the main source of water providing life to people in the mountain region especially in the Kurdistan region northern Iraq. Spring water is the common source of public water supply in most rural communities of developing countries such as Duhok city. Studies were carried out between January and July 2017. The rural communities in Barware Sheree depend on spring water for their domestic needs. The groundwater quality of District Barware Sheree has been assessed to see the suitability of groundwater for drinking and applications. In order to characterize springs water quality in Barware Sheree district, nineteen springs were selected to represent their water quality. Monthly sample was collected from the springs for the period between January and July 2017. The physical and chemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), total alkalinity (TA), Nitrate (NO3-), total hardness (TH) Calcium (Ca2+), magnesium (Mg2+), Chloride (Cl-), Nitrate (NO3-), Sulfate (SO4 2-) were analysed to know the present status of the spring water quality. The results were compared with World health organization standard. The results show the difference between the spring water quality.in the measured parameters. The water quality of all springs was soft water, except Giraye springs which have TDS more than 500 mg/l, the levels of conductivity (730) µs/cm. pH of all springs ranged between (7.4- 8.4) these pH values were alkaline side, it can be seen all the sampling sites had pH level falling with the recommended range of (6.5-8.5), the sulfate concentration in all springs of the study area was below the guidelines of 250 ml/l. Nitrate values were below the guidelines of 45 mg /l, the research concluded that Barware Sheree springs within the studied area were of conduit type as the exhibit monthly variation in temperature of water quality.

Keywords: Groundwater quality, springs, physical and chemical parameter, Northern Iraq

INTRODUCTION

All life forms especially humans depend on their surrounding biophysical environment for their well-being and survival but due to overuse of these resources, the environment has been degrading rapidly. Among these fundamental resources, water is one of the most important natural resources for humans, wildlife and the whole environment. Assessment of ambient water quality determines its use for humans and ecological purposes (1). Spring water does not require any treatment to meet drinking water standers. Quality of water is getting changed by the interaction between soil and water, soil-gas, rocks, residence time and reactions that take place within the aquifer (2). Groundwater quality is determined by the solutes, flow paths and soil gases dissolved in the water, as well as the matter, suspended in and floating on the water. Hence, groundwater quality is a consequence of the natural physical and chemical state of the water as well as any alteration factors that may have occurred as a consequence of human activity and microbial activities in soils (3). In Barware Sheree district the most common source of the drinking water for the inhabitants is springs and wells, because there is a lack of watersheds, dams, rivers or lakes. Hence, the springs and wells are the main sources of water available to the village's community settlement Northern Erbil government, Kurdistan Region, Northern Iraq. The geology of the study areas were- Fragmental detritus- represented by small rocks fragments. The quaternary is represented by alluvial and diluvial deposit, Kolosh: represented by alteration of clay marl, dolomite marl, and clay-limestone polemicist sandstone, Gecus which represented by an alteration of dolomite marl, marl dolomite and siltstone with some gypsum rocks and pelaspi limestone represented by slightly dolomite limestone and dolomite (4).

These water supplies are important public health issue because they are often vulnerable and may cause microbiological or chemical quality-associated health risks to the water consumers. Therefore, the quality control of natural spring and well water is an area of interest (5). The objectives of the present study were to: 1- to assess the water quality of Barware Sheree springs in terms of their physical, chemical parameters. 2- a comparison of assessed parameters with WHO standards for potable water to predict its potential human health risks; and finally. 3- additional comparison of selected springs of Barware Sheree with each other in order to identify the safe drinking water points.

MATERIALS AND METHODS

Water samples were collected from various spring water sources located in Barware Sheree district (figure 1). Monthly samples were collected from the springs during the period from January to July 2017. A total of 152 water samples were collected. The samples were collected in sterilized white polyethylene bottles previously rinsed with deionized water and preserved with a 0.2M HNO3 to immobilize the metals against surface adsorption. The samples were tightly caped and placed in a cool box immediately .They were then transported to the laboratory, and then filtered using filter papers to avoid interference due to turbidity and color. The water samples were tested for pH, electrical conductivity (EC), total dissolved solids (TDS), total alkalinity (TA), Nitrate (NO3-), Sulfate (SO4 2-) total hardness (TH) magnesium (Mg2+), Calcium (Ca 2+), according to the standard methods (APHA, 1999)(6). The pH, temperature and electrical conductivity parameters of the samples were determined in the field at the point of collection of the samples with appropriate instruments. Total hardness (T.H) Na2EDTA Titrimetric Method (digital burette) EPA- (O.S.19), Calcium (Ca2+) Na2EDTA Titrimetric Method (digital burette) EPA-(O.S.19,) Magnesium (Mg2+) Na2EDTA Titrimetric Method (digital burette) EPA (O.S.19), Chloride (Cl-) AgNO3Titrimetric Method(digital burette) EPA- (O.S. 21), Sulfate (SO4 2-) in mg/l: was determined nephelometrically using ELICO-52 Nephelometer.

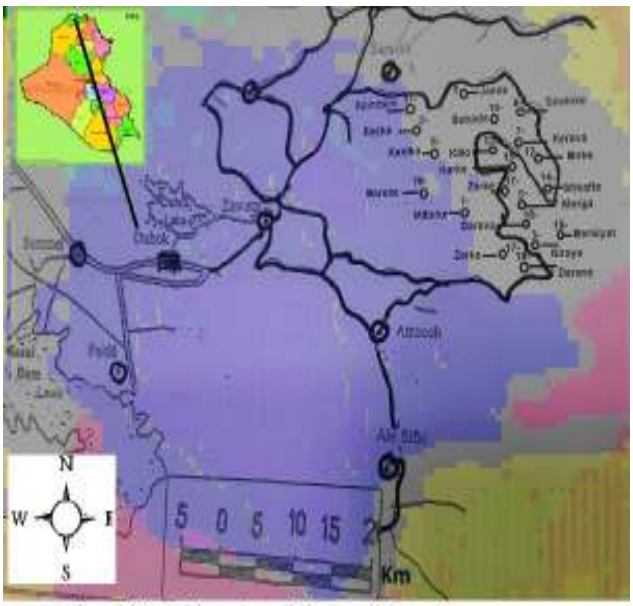

Figure (1): Site location of the studied springs

RESULTS AND DISCUSSION

Water temperature (T°C): Water temperature of all the nineteen springs varied from (9.3 to 20.6) ◦C and has a close relation to the variation of atmospheric temperature. Table (1) shows that the temperature of the spring's water varies throughout the study period. Dropping in winter and rising in summer. This indicates that these springs were of conduit type, which is affected by the runoff in

winter and spring which does not allow them to come in chemical equilibrium due to the low residence time and short path length because of the mountainous topographic nature of the area (7). Table (1) revealed that the minimum value was (9.3◦°C) recorded in site Milbrke spring in January, while the maximum value of (20.6 °C) was recorded in site Zarke spring in July. The variation in the water temperature may be due to different timing of collection and influence of seasons .The result obtained is in agreement with (2).

Table (1): Temperature variation between selected springs for the study period °C

Months / Sites	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Average
1-Mlbrke	9.3 gh	9.4 ij	10.5 q	10.9 q	12.5q	14.0 m	16.1 p	11.8 f
2- Razka	10.3 efg	9.9 hij	11.2 o	11.8 p	13.1 p	15.7 L	17.4 n	12.7 ef
3- Giraye	9.4 gh	10.6 g-j	10.9 p	12.6 o	14.8 o	16.3 i	18.0 j	13.2 def
4- Kavela	8.6 hi	9.7 hij	11.6 m	13.4 n	15.2 m	17.4 g	17.5 m	13.3 def
5-Merge	10.4 efg	10.9 f-j	12.5 k	14.1 L	14.9 n	16.1 j	16.8 o	13.6 c-f
6-.Kanika	11.7 def	13.1 a-d	13.8 h	15.3 f	16.2 j	16.9 h	17.7 L	15.0 a-d
7- karava	10.6 i	10.4 hij	11.5 n	14.6 j	15.9 L	17.4 g	18.5 h	14.1 b-f
8-Sowanke	13.6 bc	12.7 a-e	13.8 h	15.4 e	16.8 h	16.9 h	17.4 n	15.2 a-d
9-Jmate	14.8 fgh	14.2 a	14.5 c	15.3 f	17.4 e	18.0 f	18.8 h	16.1 b-e
10- Bebade	12.7 cd	12,4 b-f	13.9 g	14.7 i	18.9 a	19.0 a	19.2 d	15.8 ab
11-Spindare	13.3bcd	13.0 a-d	14.2 e	15.1 h	17.4 e	18.1 e	18.9 f	15.7 abc
12-Birke	11.9 de	11.4 d-h	12,6 j	14.3 k	15.2 m	15.8 k	17.5 m	14.1 b-e
13-Klilo	14.7 ab	14.1 ab	15.8 b	17.4 a	18.3 b	18.6 b	19.6 b	16.9 a
14-Shkafte	9.5 gh	9.2 j	11.8 L	13.9 m	16.1 k	17.4 g	17.8 k	13.6 c-f
15-Karke	13.7 bc	12.3 c-g	14.4 d	15.2 g	17.5 d	18.3 d	19.1e	15.7 ab
16-Bareke	10.4 efg	10.2 hij	13.8 h	16.4 b	16.9 g	17.4 g	18.3 i	14.7 b-e
17-Zarke	15.8 a	13.6abc	15.9 a	15.8 c	17.8 c	18.5 c	20.6 a	16.8 a
18-Darave	11.9 de	11.2 e-i	13.7 I	14.3 k	16.6 i	18.5 c	18.8 g	15.0 a-d
19-Berkyat	12.8 cd	12.2 c-g	14.1 f	15.7 d	17.1 f	19.0 a	19.4 c	15.7 abc

Electrical conductivity (EC) in µs/cm: Table (2) shows the variation for EC among the studied springs. The Giraye spring has the highest EC among the studied springs during the study period, it recorded (730) µs/cm in April. The conductivity is produced by the erosion of the natural deposits and the dissolution of the mineral from the media which the water passes through. While the lowest value was recorded in Merge spring was (383) µs/cm, in March. The values obtained in all sampling sites were within the standard value of WHO drinking water quality which is 1000 µs/cm. That means the water fit for consumption. This value was significantly lower than those reported in (8).

Total dissolved solids (TDS) in mg/l: The concentrations of TDS in all sampling sites were ranged from (238 to 581) mg/l. Berkyat spring recorded the lowest (TDS) value along the study period was (238) mg/l. in January, while Giraye spring recorded the maximum (TDS) value along the study period was (581) mg/l, in June (table 3). These values were within the standard limits of drinking water quality (500 mg/L) set by WHO (9) and this finding was lower than the TDS of some spring in north Iraq, Duhok city (10). Similar results were reported by (11).

pH: Table (4) shows the variation in pH values among the studied springs, In this study the concentration of pH ranges from (7.4 to 8.4) the minimum value of (7.4) was recorded in site Shkafte spring in January, while the maximum value of (8.4) was recorded in site klilo spring in May. High values are often caused by high bicarbonate and carbonate concentrations, known as alkalinity. All the water samples analyzed have a concentration within the safe limit of 6.5 to 8.5 standard set by (12).The mentioned value was significantly higher than those reported by (2).

Dissolved oxygen (DO) in mg/l: The values of DO in all sampling sites ranged from (6.6 - 8.4) mg/l (table 5). The absence of any organic pollution in these springs and the shallow feeding source of these springs, While the lowest value was recorded in site Giraye spring was (6.6) mg/l during July. An ideal DO value of 5.0 mg/l is the standard for drinking water set by WHO (12).

Table (2): Electrical conductivity EC between selected spring, µs/cm

Months / Sites	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Average
1-Mlbrke	444 cde	462 bcd	395 r	476 n	439 o	387 q	451 m	436 d
2- Razka	530 a-d	546 a-d	551 e	539 h	486 L	544 e	559 d	536 c
3- Giraye	713 a	692 a	728 a	730 a	686 a	708 a	722 a	711 a
4- Kavela	548 a-d	561 a-d	508 k	538 I	553 f	544 e	555 f	543 c
5-Merge	427 cde	507 bcd	383 r	411 s	409 q	433 m	441 o	430 d
6-.Kanika	560 a-d	548 a-d	531 h	556 g	573 e	538 f	547 g	550 c
7- karava	492 e	511 bcd	529 i	487 m	480 m	521 i	510 k	577 c
8-Sowanke	618 abc	637 ab	628 c	609 c	582 d	599 d	620 c	613 b
9-Jmate	589 de	682 cd	620 d	573 d	592 c	611 c	620 c	612 b
10- Bebade	514 b-e	589 a-d	532 g	511 k	528 i	509 j	500 L	526 c
11-Spindare	488 b-e	411 d	408 p	473 o	486 L	406 p	403 r	439 d
12-Birke	539 a-d	541 a-d	512 j	561 e	548 h	530 h	539 i	538 c
13-Klilo	436 cde	440 d	428 o	444 p	406 r	419 n	428 p	428 d
14-Shkafte	659ab	628 abc	646 b	666 b	651 b	642 b	650 b	648 b
15-Karke	534 a-d	528 a-d	541 f	529 j	504 k	533 g	543 h	530 c
16-Bareke	499 b-e	502 bcd	487 L	494 L	511 j	521 i	418 q	490 cd
17-Zarke	448 cde	442 d	463 m	413 r	452 n	441 k	449 n	444 d
18-Darave	554 a-d	549 a-d	551 e	559 f	551 g	411 o	532 j	529 c
19-Berkyat	433 cde	428 d	431 n	440 q	429p	438 L	556 e	450 c

Table (3): TDS between selected spring water for the study period (mg/l)

Months Sites	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Average
1-Mlbrke	386 cde	247 fg	296 L	272 q	215 r	243 r	244 p	271 hi
2- Razka	347 def	328 cd	331 h	436 d	329 j	333 i	343 i	349 fe
3- Giraye	508 a	539 a	556 a	514 a	569 a	581 a	577 a	549 a
4- Kavela	460 ab	439 b	360 g	359 h	363 f	309 m	328 k	374 d
5-Merge	439 bc	442 b	431 b	439 c	428 b	418 d	433 c	432 b
6- Kanika	367 de	359 c	370 d	360 g	366 e	338 h	341 j	357 def
7- karava	320 de	297 def	288 m	311 m	332 i	325 j	318 L	313 g
8-Sowanke	410 bcd	421 b	422 c	493 b	418 c	431 c	420 d	430 b
9-Jmate	390 ab	468 a	366 e	411 e	398 d	372 f	371 e	396 c
10- Bebade	335 efg	358 c	328 i	340 I	322 k	349 g	366 f	342 f
11-Spindare	247 h	222 g	253 q	248 s	235 q	248 q	229 q	240 j
12-Birke	354 def	338 cd	362 f	335 k	352 h	461 b	346 h	364 def
13-Klilo	281 gh	273 ef	241 r	286 n	308 n	311 L	272 n	281 hi
14-Shkafte	274 gh	286 def	277 n	269 r	302 o	286 n	244 p	276 hi
15-Karke	350 def	336 cd	366 e	332 L	363 f	395 e	461 b	371de
16-Barake	325 efg	311 cde	321 j	338 j	309 m	316 k	113 r	290h
17-Zarke	296 fgh	304 de	276o	284 o	311L	282 o	277 m	290 h
18-Darave	364 de	358 c	318 k	378 f	362g	372 f	351 g	358 def
19-Berkyat	238 h	289 def	260 p	277 p	260 p	259 p	263 o	263 i

Table (4): pH variation between selected spring water for the study period

Months / Sites	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Average
1-Mlbrke	7.8 c	7.7 g	7.8 f	7.6 h	7.8 f	7.7 f	7.9 d	7.7cde
2- Razka	7.7 d	7.6 h	7.8 f	8.1 c	7.5 i	7.6 g	8.0 c	7.7 cde
3- Giraye	7.8 c	8.0 e	7.9 e	8.0 d	7.7 g	7.6 g	7.7 f	7.8 cd
4- Kavela	7.6 e	7.7 g	7.8 f	7.6 h	8.1 c	8.0 d	7.8 e	7.8 cd
5-Merga	7.5 f	7.6 h	8.0 d	7.8 f	7.5 i	7.7 f	7.6 g	7.6 ef
6-Kanika	7.8 c	7.6 h	7.9 e	7.7 g	7.8 f	7.6 g	7.5 h	7.7 def
7- karava	8.3a	8.3 c	8.2 b	8.3 a	8.1 c	8.0 d	8.1 b	8.1 ab
8-Sowanke	8.3 a	8.5 a	8.1 c	7.9 e	7.7 g	8.2 b	8.0 c	8.1 b
9-Jmate	7.6 e	7.8 f	7.6 g	7.9 e	7.8 f	8.1 c	7.9 d	7.8 cd
10- Bebade	8.3 a	8.1 d	8.3 a	8.2 b	8.3 b	8.0 d	8.2 a	8.2 ab
11-Spindare	7.5 f	7.7 g	7.5 h	7.6 h	7.5 i	7.6 g	7.8 e	7.6 f
12-Birke	7.6 e	7.5 i	8.1 c	8.0 d	8.1 c	7.8 e	7.9 d	7.8 c
13-Klilo	8.2 b	8.4 b	8.1 c	8.2 b	8.4 a	8.3 a	8.2 a	8.2 a
14-Shkafte	7.4 g	7.5 i	7.6 g	7.8 f	7.6 h	8.1 c	7.7 f	7.6 ef
15-Karke	7.5 f	7.7 g	8.1 c	8.0 d	7.9 e	8.1 c	7.8 e	7.8 c
16-Barake	7.6 e	7.5 i	8.0 d	7.7 g	7.6 h	7.5 h	7.6 g	7.6 ef
17-Zarke	7.5 f	7.6 h	7.4 I	7.8f	8.0 d	7.6 g	7.4 i	7.6 f
18-Darave	7.5 f	7.4 j	7.6 g	7.4 I	7.5 i	7.6 g	7.5h	7.5 g
19-Berkyat	7.6e	7.6 h	7.8 f	7.6h	7.5 i	7.5 h	7.6 g	7.6 fg

Table (5): Dissolved oxygen between selected springs water for the study period, (mg/l)

Months / Sites	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Average
1-Mlbrke	8.1ab	8.2 bc	8.0 d	8.1 a	7.5 e	6.8 h	7.7 d	7.7 bcd
2- Razka	7.8 cd	8.0 d	7.8 f	7.5 f	6.8 i	7.0 f	7.2 i	7.4 fgh
3- Giraye	6.9 f	6.7 h	6.8 k	7.2 g	6.7 j	6.9 g	6.6 n	6.8 j
4- Kavela	7.8 cd	6.8 h	7.2 j	6.9 I	7.3 g	6.9 g	6.3o	7.0 ij
5-Merge	7.4 e	7.7 ef	7.5 h	6.8j	7.7 c	6.9 g	6.7 m	7.2 hi
6-G.Kanika	7.8 cd	7.5 g	7.6 g	7.2 g	7.4 f	6.7 i	7.5 f	7.3 gh
7- karava	8.3 a	8.4 a	8.3 a	8.1 a	6.9 h	7.4 e	6.8 L	7.7 b-e
8-Sowanke	8.1 ab	8.2 bc	8.1 c	7.8 c	7.6 d	6.8 h	7.4 g	7.7 c-f
9-Jmate	8.4 ab	8.3 c	7.9 e	8.0 b	7.8 b	7.6 d	6.9 k	7.8 a-d
10- Bebade	8.2 a	8.3 ab	8.1 c	7.7 d	7.9 a	8.0 a	8.1 a	8.0 a
11-Spindare	7.9 cd	7.7 ef	7.8 f	7.7 d	6.8 i	7.9 b	7.7d	7.6 c-g
12-Birke	7.9 cd	7.5 g	7.2 j	6.8 j	6.7 j	6.8 h	7.0 j	7.1 i
13-Klilo	7.7 d	7.8 e	7.9 e	7.8 c	7.6 d	6.9 g	6.7 m	7.4 e-h
14-Shkafte	7.8 cd	7.6 fg	7.8 f	7.6 e	7.3 g	7.4 e	7.8 c	7.6 c-g
15-Karke	8.3 a	8.1 cd	7.4 i	7.6 e	6.9 h	7.4 e	7.3 h	7.5 d-g
16-Barake	8.0 bc	8.3 ab	8.1 c	7.0 h	7.3 g	6.8 h	7.6 e	7.5 d-g
17-Zarke	8.2 a	8.0 d	8.2 b	8.0 b	7.8 b	7.9 b	8.0 b	8.0 ab
18-Darave	8.3 a	8.0 d	7.9 e	8.1 a	7.6 d	7.8 c	7.5 f	7.8 abc
19-Berkyat	7.9cd	7.8 e	7.9 e	7.8c	7.6 d	7.8 c	7.4 g	7.7 b-e

Biochemical oxygen demand (BOD) in mg/l: The values of BOD in all sampling sites ranged from 0.6 to 1.8 mg/l (table 6) The minimum value of (0.6) mg/l was recorded in sites Sowanke spring in February, while the maximum value of (1-8) mg/l was recorded in site kavela spring in March. This decrease of (BOD) value indicates the absence of any organic pollution. Similar results was reported by (1).

Table (6): (BOD), of spring water among the studied period mg/l

Months / Sites	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Average
1-Mlbrke	1.0 e	1.3 b	0.9 h	1.3 d	1.5 d	1.8a	1.4 d	1.3bc
2- Razka	0.9 f	1.0 b	1.4 d	1.0 g	1.2 g	0.9 h	0.8 h	1.0 e-h
3- Giraye	0.9 f	1.1 b	0.8 i	1.1 f	1.3 f	1.0 g	1.3 e	1.0 e-h
4- Kavela	1.6 b	1.4 b	1.8 a	1.5 b	1.7 b	1.4 d	1.6 b	1.5 a
5-Merge	0.8 g	0.7 b	0.9 h	1.3 d	1.1 h	0.9 h	1.0 g	0.9 gh
6- Kanika	1.0 e	1.2 b	1.5 c	1.3 d	1.0 i	1.2 e	1.5 c	1.2 cd
7- karava	1.1 d	1.1 b	0.8 I	1.3 d	0.9 j	1.2 e	1.6 b	1.1 ed
8-Sowanke	0.9 f	0.6 b	0.9 h	1.2 e	0.9 j	1.5 c	1.3 e	1.0 e-h
9-Jmate	0.8 g	0.7 a	0.8 I	1.3 d	1.8 a	1.2 e	1.5 c	1.1 cde
10- Bebade	1.1 d	1.3 b	1.0 g	0.8 i	1.6 c	1.2 e	1.7 a	1.2 cd
11-Spindare	0.8 g	1.0 b	0.7 j	1.0 g	1.2 g	0.9 h	1.0 g	0.9 gh
12-Birke	0.7 h	0.7 b	1.3 e	0.9 h	1.4 e	0.7 j	1.1 f	0.9 fgh
13-Klilo	1.0 e	1.1 b	1.2 f	1.5 b	1.3 f	0.8 i	1.3 e	1.1 cde
14-Shkafte	1.1 d	0.8 b	1.3 e	1.0 g	1.2 g	0.8 i	1.0 g	1.0 e-h
15-Karke	0.8 g	0.7 b	0.8 I	1.0 g	0.7 k	0.9 h	1.3 e	0.8 h
16-Bareke	0.7 h	0.9 b	1.0 g	1.5 b	1.3 f	1.1 f	1.4 d	1.1 de
17-Zarke	1.3 c	1.7 ab	1.5 c	1.8 a	1.6 c	1.4 d	1.7 a	1.5 a
18-Darave	0.9f	1.0 b	0.7 j	0.9 h	1.4 e	1.5 c	1.3 e	1.1 d-g
19-Berkyat	1.7a	1.3 b	1.6 b	1.4 c	1.1 h	1.6 b	1.4 d	1.4 ab

Total hardness (TH) in (mg/l) as CaCO3: the values of total hardness in all sampling sites ranged from (200 to 386) mg/l. The minimum value was recorded in site sowanke spring was 200 mg/l, during March, while the maximum value was recorded in site Giraye spring was (386) mg/l, during January. (table 7). The increase of hardness may be due to carbonaceous nature of the geological formation of Barware Sheree region especially limestone and dolomite contribute to hardness increase as the water pass through them. The water quality analysis showed the hardness values of the spring water samples were within the permissible limit and is safe for drinking and other domestic uses. In this study are significantly lower than those reported in (3).

Total Alkalinity (TA) in mg/l: in (table 8) the values of total alkalinity in all sampling sites ranged from (137-396) mg/l the maximum value was recorded in site shkafte spring was 395 mg/l in February. The excess of alkalinity due to the presence of bicarbonates, carbonates and hydroxide of calcium, magnesium, sodium, potassium, and salts of weak acids and strong bases as borates, silicates, phosphates (11), while the minimum value was recorded in site Merge spring was137 mg/l. The various ionic species that contribute mainly to alkalinity include bicarbonates, carbonates, and hydroxides. The sites 3,7,11, 14, 18 within maximum permissible limit but the most rest sites of alkalinity are in the Permissible limit. In this study are significantly higher than those reported in (13).

Chloride (Cl-) in mg/l: For Chloride (table 9), the lowest concentration were recorded in site klilo spring was (2.1) mg/l in February, while the highest value was recorded in site Merge spring was (13.9) mg/l in March. The high chloride concentration may be attributed due to solid waste leaching from upper soil layers in dry climates and natural geochemical activities in the area. The chloride level recorded in the entire sampling points of the spring water was within the permissible levels of chloride for safe drinking water set by WHO (9) (250 mg/L) These concentration were lower than those recorded in the springs of Zaweta Duhok city studied by (10). In this study are significantly higher than those reported by (14).

Sulfate (SO4 2-) in mg/l: Table (10) shows sulfate value in the studied springs along the study period. It ranged between (4.8 to 39.5) mg/l, the highest concentration was recorded in site klilo spring was 39.5 mg/l in June. Sulfate is mobile in soil and can enter groundwater. While the lowest concentration was recorded in site Milbrke was (4.8) mg/l in March. The sulfate value in the springs of the study area was below the guidelines of (1) of 200 mg/l. This result also confirms the acceptability of the spring water for drinking and other domestic uses in terms of their sulfate contents. In this study are significantly lower than those reported by (10).

Table (7): Total hardness between selected springs for the study period, (mg/l)

Months / Sites	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Average
1-Mlbrke	280 j	260 b-e	231 m	254 k	268 j	263 h	271 f	261 hi
2- Razka	240 m	221 cde	231 m	228 m	218 n	217 p	211 n	210 k
3- Giraye	386 a	359 a	358 a	361 a	349 a	358 a	341 a	358 a
4- Kavela	290 h	273 b-e	267 j	283 f	263 k	257 k	266 h	271 fg
5-Merge	240 m	222 cde	208 o	218 n	211 p	223 o	219 m	220 k
6-Kanika	330 b	311 ab	320 b	212 p	300 c	298 d	285 d	293 cd
7- karava	256 L	231 b-e	220 n	217 o	231 m	228 n	211 n	227 k
8-Sowanke	228 n	205 de	200 q	211 q	212 o	204 q	201 o	208 L
9-Jmate	320 c	311 de	290 f	288 d	291 d	305 c	287 c	298 bc
10- Bebade	280 j	263 b-e	255 k	243 L	263 k	254 L	241 k	257 ij
11-Spindare	220 o	198 e	201 p	184 r	191 q	201 r	194 p	198 m
12-Birke	308 e	301 abc	281 h	288 d	275 f	281 f	276 e	287 de
13-Klilo	270 k	246 b-e	251 L	256 j	248 L	240 m	244 j	250 j
14-Shkafte	290 h	271 b-e	282 g	268 g	271 i	260 j	266 h	272 fg
15-Karke	288i	263 b-e	272 i	263 h	272 h	261 i	268 g	269 gh
16-Bareke	303 g	285 a-d	291 e	284 e	275 f	281 f	237 L	279 ef
17-Zarke	314 d	301 abc	292 d	305 b	306 b	309 b	295 b	303 b
18-Darave	280 j	264 b-e	272 I	258 i	274 g	265 g	259 i	267 gh
19-Berkyat	306 f	284 a-d	301 c	295 c	277e	284 e	271 f	288 de

Table (8): Total Alkalinity between selected springs for the study period, (mg/l)

Months / Sites	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Average
1-Mlbrke	173 o	192 L	204 j	184 m	218 k	169 ghi	194 L	190 g
2- Razka	237 k	271 h	284 g	195 L	147 r	206 efg	200 k	220 f
3- Giraye	372 c	395 b	328 d	385 a	339 d	361 ab	382 a	366 a
4- Kavela	163 p	183 n	174 n	159 q	182 m	192 fgh	168 q	174 h
5-Merge	137 q	198j	153 p	174 o	174 n	167 hi	183 n	169 h
6-.Kanika	275 g	284 g	294 e	259 g	284 f	295 c	283 g	282 c
7- karava	305 e	351 d	372 b	296 e	319 e	288 c	308 e	362 b
8-Sowanke	184 m	149 p	174n	197 k	149 q	140 i	172 p	166 h
9-Jmate	273 i	294 f	219 i	276 f	271 h	259 ef	238 j	261 de
10- Bebad	269 j	241 i	198 k	250 h	263 i	241 de	284 f	249 e
11-Spindar	369 d	383 c	339 c	375 b	382 a	352 b	375 b	367 a
12-Birke	173 o	174 o	182 m	160 p	174 n	191 fgh	185 m	177 h
13-Klilo	284 f	294 f	285 f	239 j	258 j	264 c	270 I	270 cd
14-Shkafte	375 b	396 a	328 d	370 d	368 c	395 a	358 d	370 a
15-Karke	174 n	197 k	160 o	147 r	183 L	162 hi	149 r	167 h
16-Bareke	191 L	185 m	149 q	178 n	171 o	195 fgh	183 n	153 gh
17-Zarke	274 h	296 e	275 h	249 i	283 g	291 c	275 h	277 c
18-Darave	385 a	351 d	396 a	374 c	381 b	369ab	360 c	377 a
19-Berkyat	184 m	139q	194 L	160 p	158 p	146 i	174 o	165 h

Table (9): Chloride variation between selected springs for the study period,(mg/l)

Months / Sites	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Average
1-Mlbrke	9.6 e	8.7 e	9.2 e	10.1 e	9.8 e	8.8 f	9.3 e	9.3 d
2- Razka	12.3 b	10.8 c	12.8 b	9.9 f	11.6 b	12.2 d	11.8 d	11.6 b
3- Giraye	8.3 g	11.6 b	9.4 d	10.2 d	12.5 a	13.1 b	12.4 c	11.0 bc
4- Kavela	10.7 d	8.6 f	7.8 g	9.3 g	8.5 g	7.9 g	9.0 f	8.8 d
5-Merge	13.3 a	12.6 a	13.9 a	10.6 c	11.4 c	13.7 a	13.9 b	12.7 a
6-G.Kanika	8.5 f	10.1 d	8.6 f	12.0 a	9.6 f	10.6 e	1o.3 a	9.9 c
7- karava	7.3 h	8.6 f	6.4 h	7.4 h	8.0 h	7.4 h	8.6 g	7.6 e
8-Sowanke	11.5 c	10.8 c	12.1 c	11.4 b	10.6 d	12.3 c	11.8 d	11.5 b
9-Jmate	6.2 i	5.7 g	5.3 j	6.2 j	5.9 i	6.6 i	5.9 j	5.9 f
10- Bebade	4.1 L	3.8 L	4.0 m	2.9 o	3.1 n	2.7 p	3.1 o	3.3 h
11-Spindar	2.6 p	3.0 n	2.8 p	2.4 q	2.8 p	3.0 o	2.8 p	2.7 i
12-Birke	6.2 i	5.3 i	5.1 k	6.7 i	5.9 i	6.3 j	6.6 h	6.0 f
13-Klilo	2.4 r	2.1 q	2.6 q	1.8 r	1.9 r	2.4 q	2.0 r	2.1 j
14-Shkafte	3.4 n	3.5 m	2.6 q	3.9 m	3.3 m	3.8 n	3.9 m	3.4 h
15-Karke	5.2 j	5.6 h	6.3 i	6.7 i	5.8 j	6.1 k	6.0 i	5.9 f
16-Bareke	4.7 k	4.3 j	4.7 L	4.0 L	4.1 L	4.9 m	4.7 L	4.5 g
17-Zarke	3.9 m	4.2 k	3.6 n	4.2 k	4.7 k	5.1 L	4.8 k	4.3 g
18-Darave	2.5 q	2.8 o	2.5 r	3.1 n	2.7 q	3.8 n	3.6 n	3.0 hi
19-Berkyat	2.9 o	2.5 p	3.1 o	2.5 p	2.9 o	3.0 o	2.4 q	2.7 i

Table (10): sulfate variation between selected springs for the study period, (mg/l)

Months / Sites	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Average
1-Mlbrke	5.3 s	6.1 p	4.8 L	6.2 r	7.5 r	6.4 g	5.9 s	6.0 k
2-Razka	7.0 r	7.4 o	7.1 k	7.4 q	7.2 s	6.9 g	7.4 r	7.2 k
3- Giraye	9.4 n	8.2 m	7.8 jk	10.3 o	9.1 p	11.4 gef	10.0 p	9.4 j
4- Kavela	8.2 p	7.9 n	10.5 k	12.4 L	11.9 L	12.6 d-f	12.8 m	10.9 j
5-Merga	18.4 e	16.2 g	17.4 de	18.3 g	16.5 g	18.9 a-f	20.7 f	18.0 de
6-G.Kanika	13.7 k	14.0 i	13.8 g	14.6 i	15.3 j	11.9 d-f	14.9 k	14.0 gh
7- karava	10.4 L	11.3 k	9.8 hi	12.2 m	11.7 n	10.6 gef	11.4 n	11.0 ij
8-Sowanke	19.6 d	20,5 d	18.2 cd	20.6 d	21.3 d	20.7 a-d	22.8 d	20.5 d
9-Jmate	17.5 f	18.1 e	16.3 ef	17.9 h	15.8 I	18.3 a-f	19.1 h	17.5 de
10- Bebade	7.9 q	8.2 m	7.5 jk	10.6 n	8.4 q	11.2 gef	10.8 o	9.2 j
11-Spindare	16.8 h	14.3 h	17.4 de	14.6 i	17.2 f	15.9 b-f	18.3 I	16.3 ef
12-Birke	8.8 o	9.2 L	8.6 ij	9.4 p	10.3 o	9.6 fg	9.3 q	9.3 j
13-Klilo	28.3 a	29.6 a	31.6 a	36.9 a	41.7 a	39.5 b-f	41.8 a	35.6 a
14-Shkafte	14.7 j	17.3 f	16.9 def	18.5 e	16.3 h	20.4a-d	19.6 g	17.6 de
15-Karke	9.7 m	11.6 j	10.4 h	12.6 k	11.8 m	14.3 c-g	16.0 j	12.0 hi
16-Bareke	17.4 g	14.0 i	15.7 f	13.9 j	15.1 k	15.9b-f	14.6 L	15.2 fg
17-Zarke	15.9 I	17.3 f	15.8 f	18.4 f	20.5 e	22.3 abc	21.7 e	18.8 d
18-Darave	20.4 c	22.1 c	19.4 c	22.7 c	21.6 c	23.8 ab	23.0 c	21.8c
19-Berkyat	26.2 b	27.4 b	25.9 b	27.3 b	29.5 b	26.4 a	30.7 b	27.6 b

Nitrates (NO3-) in mg/l: the levels of nitrate in all the sampling sites were ranged from 0.6 to 4.8mg/l, the highest value was recorded in site Kanika spring was (4.8) mg/l in March. High concentration of nitrates in groundwater has been related with excessive use of nitrogen fertilizers in agriculture and high amount of organic waste generated by the human population, while the lowest value was recorded in site Merge spring was (0.6) mg/l in February (table 11). Nitrates (NO3 -) are normal in groundwater and surface water. The nitrate concentration in the springs of the study area was below the guidelines of WHO (12) of 45 mg/l. Nitrate are very soluble and do not bind with soil, therefore, it has high potential to migrate to springs water. The average value of nitrite of spring water in the present study ranged between (0.9 -4.1) mg/l. Similar results reported by in (15).

Table (11): Nitrate variation between selected springs for the study period, (mg/l)

Months / Sites	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Average
1-Mlbrke	1.1 L	0.9 k	1.3 h-k	1.5 k	0.8 n	1.0 ij	0.9 o	1.0 ijk
2- Razka	2.4 f	2.1 d	1.8 gh	2.7 d	1.4 j	2.6 de	2.1 i	2.1 fg
3- Giraye	1.8 h	1.3 h	1.0 jk	2.1 f	1.9 g	2.0 fg	1.8 j	1.7 h
4- Kavela	3.0 d	2.6 b	3.1 efg	3.4 c	2.8 d	3.3 bc	3.5 c	3.1 c
5-Merge	0.8 n	0.6 m	0.9 k	1.3 m	1,0 m	0.8 j	1.2 L	0.9 kj
6-.Kanika	4.2 a	3.9 a	4.8 a	3.5 b	4.6 a	3.7 b	4.3 a	4.1 a
7- karava	1.3 k	0.7 L	0.9 k	1.4 L	0.7 o	0.9 ij	1.1 m	1.0 jk
8-Sowank	2.0 g	1.5 g	2.8 de	2.4 e	3.1 b	2.7 fg	2.8 e	2.4 de
9-Jmate	0.9 m	0.7 L	1.6 g-j	1.2 n	0.8 n	1.3 ij	1.5 k	1.1 ijk
10-Bebade	1.6 j	0.7 L	1.7 ghi	1.4 L	1.8 h	0.9 ij	0.8 p	1.1 ij
11-Spindar	3.0 d	2.2 c	2.7 def	2.4 e	3.1 b	2.9 cd	2.4 g	2.6 d
12-Birke	4.1 b	2.6 b	3.8 b	4.2 a	2.9 c	4.6 a	4.2 b	3.7 b
13-Klilo	0.8 n	1.0 j	1.3 h-k	1.7 i	0.8 n	1.1 ij	1.0 n	1.1 ijk
14-Shkafte	1.8 h	1.1 I	1.9 gh	1.6 j	1.3 k	1.1 ij	0.8 p	1.3 i
15-Karke	2.0 g	1.8 f	2.7 def	1.3 m	2.4 f	2.1 fg	2.2 h	2.0 fg
16-Barake	0.9 m	0.7 L	1.1 ijk	0.8 o	1.0 m	0.9 ij	1.1 m	0.9 k
17-Zarke	3.8 c	2.0 e	3.5 bc	1.8 h	1.2 L	1.4 hi	0.7 q	2.0 fg
18-Darave	1.7 i	1.0 j	2.1 fg	2.7 d	1.6 I	2.4 ef	2.6 f	2.0 g
19-Berkyat	2.7 e	1.3 g	3.1 cd	1.9 g	2.6 e	1.8 gh	3.1 d	2.3 ef

CONCLUSION

In this study physical and chemical parameters such as EC, pH, TDS, total hardness, total alkalinity, Cl-, NO3 -, SO4 2- and DO of the spring water were measured. From the experimental data, it was found that all the parameter which are analyzed are within the permissible limit. Except TDS in site giraye spring recorded higher than 500 mg/l. was above the acceptable limit. Most of the springs yield potable water with moderate dissolved salts, hardness is also lower than the permissible limits. pH was on the alkaline side (7.4 - 8.4), and within the permissible limit. Water resources of the study area are generally fresh and excellent for drinking purposes, the water of the spring of Barware Sheree within the studied area cannot be utilized for the bottled water production without treatment.

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