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Assessment Of Some Physicochemical And Biological Characteristics Of Spring Water In Al Qayqab, Libya

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A B S T R A C T

Drinking water to be consumed safely should be qualified by applying physical, chemical, and biological tests on a routine basis. This study aims to evaluate the portability of the water in both eastern and western springs in Al Qayqab (El-Ghegab) town located in the eastern north of Libya, by assessing some physic-chemical and microbiological parameters including; PH, Total dissolved solids (TDS), Turbidity, sodium (Na), and potassium(K); identify some heavy metals like Lead (Pb), Cadmium(Cd), Arsenic (As), and Mercury (Hg) and microbial contents including Total coliform count (TCC) and E coli as indicating to sewage pollution and comparing with guideline standards set by WHO and identify the differences in characteristics between the two spring. The analysis of selected samples at both eastern and western springs presented the average values of physical-chemical parameters; pH, turbidity, TDS, and K fall within the permissible limits set by WHO. Na means concentrations in both springs, eastern and western are 58.8 mg/l and 54 mg/l respectively, which slightly exceeded the permissible limits. We did not detect heavy metals of As, Cd, Pb, and Hg in all evaluated samples. The biological analysis detected total coli form and E coli in samples of the eastern spring indicating fecal contamination in this spring.

Keywords: spring water - physicochemical parameters - water contamination - quality assessment

تقييم بعض الخصائص الفيزيائية والكيميائية والبيولوجية لمياه الينابيع في القيقب، ليبيا

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الملخص

يجب أن تكون مياه الشرب الصالحة للاستهلاك الآمن مؤهلة من خلال تطبيق الاختبارات الفيزيائية والكيميائية والبيولوجية على أساس روتيني. تهدف هذه الدراسة إلى تقييم صلاحية مياه الشرب في الينابيع الشرقية والغربية في مدينة القيقب الواقعة شرق شمال ليبيا، و من خلال تقييم بعض المعايير الفيزيائية والكيميائية والميكروبيولوجية بما في ذلك؛ الرقم الهيدروجيني، إجمالي المواد الصلبة الذائبة، العكارة، الصوديوم ، والبوتاسيوم و تحديد بعض المعادن الثقيلة مثل الرصاص والكادميوم والزرنيخ والزئبق والمحتويات الميكروبية بما في ذلك إجمالي عدد القولونيات والإشريكية القولونية كإشارة إلى تلوث مياه الشرب بمياه الصرف الصحي ومقارنتها بالمعايير التوجيهية التي وضعتها منظمة الصحة العالمية وتحديد الفروق في الخصائص بين الينبوعين الشرقي و الغربي. أظهر تحليل عينات المختارة من الينابيع متوسط قيم المعلمات الفيزيائية والكيميائية؛ تقع درجة الحموضة والعكارة و إجمالي المواد الصلبة الذائبة و البوتاسيوم ضمن الحدود المسموح بها التي حددتها منظمة الصحة العالمية. بينما بلغ متوسط تركيز الصوديوم في كلا من الينابيع 58.8 ملغم/لتر و 54 ملغم/لتر على التوالي، وهو ما يزيد قليلاً عن الحدود المسموح بها. لم نكتشف أي من المعادن الثقيلة المختارةمثل في جميع العينات التي تم تقييمها. كشف التحليل البيولوجي عن الشكل الكلي للإشريكية القولونية والإشريكية القولونية في عينات الينبوع الشرقي مما يشير إلى وجود تلوث برازي في هذا الينبوع.

الكلمات المفتاحية: تقييم الجودة، تلوث المياه, العوامل الفيزيائية والكيميائية, مياه الينابيع

Abbreviations
WHO World Health Organization
UNICEF United Nations Children's Fund
TDS total dissolved solids
Na sodium
K potassium
PH Acidity of the water
Pb lead
Cd cadmium
Arsenic As
TCC total coliform count
Mg Mercury

Introduction

Water is one of the maximum essential resources for human beings and other living organisms (1). Given the community to sustain, sufficient clean water is fundamental. Safe drinking water is an essential requirement for great health; moreover, fundamental right for people (2). Over the last twenty years, physic-chemical and bacteriological quality has had

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research emphasis because of impacts on human health (3). Water is a vital element in the socioeconomic development of the population (4) , safe drinking water is still making challenge in developing countries, with 80 % of all morbidities and more than 30% of mortalities associated with drinking water (5)

Libya, one of the developing countries in North Africa, has limited water sources. (6). The World Health Organization (WHO) and United Nations Children's Fund (UNICEF) 2000 issued a report on global water supply and sanitation; revealing that water sources covered only 73% of the people (6). In Libya, traditional sources of drinking water are commonly wells and reservoirs supplied by rains. Non-traditional sources come from the Man-made River Project and water treatment plants (6). Since water is applied for drinking, domestic, agricultural, food production, and recreational aims, Safe water sources are crucial for public health; therefore, inappropriately managed water exposes people to avoidable health dangers. As a result, drinking unsafe water; is estimated to cause 829000 deaths each year from diarrhea, dysentery, and typhoid (7) (8), diseases and disasters related to water, for this reason, water quality assurance in many parts of the globe is established as a highest priority in the policy plans (9). However, accessibility to safe drinking water is crucial to public health (7). The drinking water to be consumed safely for domestic purposes; water quality for suitability is identified by measuring physical characteristics and concentrations of inorganic and organic elements (9)

Human activities make surface water profoundly contaminated; surface water is broadly being utilized in many human applications (1). This study aims to evaluate the potability of the water in both eastern and western springs in Al Qayqab (El-Ghegab) town by assessing some parameters including; pH, Total dissolved solids (TDS), Turbidity, sodium (Na), and potassium(K); in addition, identify some heavy metals like Lead (Ph), Cadmium(Cd), Arsenic (As), and Mercury (Hg) and microbial contents including Total coliform count (TCC) and E coli as indicating to sewage pollution and comparing with guideline standards set by WHO and identify the differences in characteristics between the two spring.

Methods

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1. **Geographical area:**

The evaluation was conducted in Al Qayqab town which is known as El-Ghegab among residents. It is a town in historical Cyrenica territory on the east side of Libya; located on the northeast away 250 kilometers from Benghazi(**خطأ! لم يتم العثور على مصدر المرجع.**). Most residents raise cattle including sheep, goats, and cows. Besides, they work in different jobs such as farming, and trading, and recently hundreds of them have been involved in public jobs including teaching, nursing, and military forces.

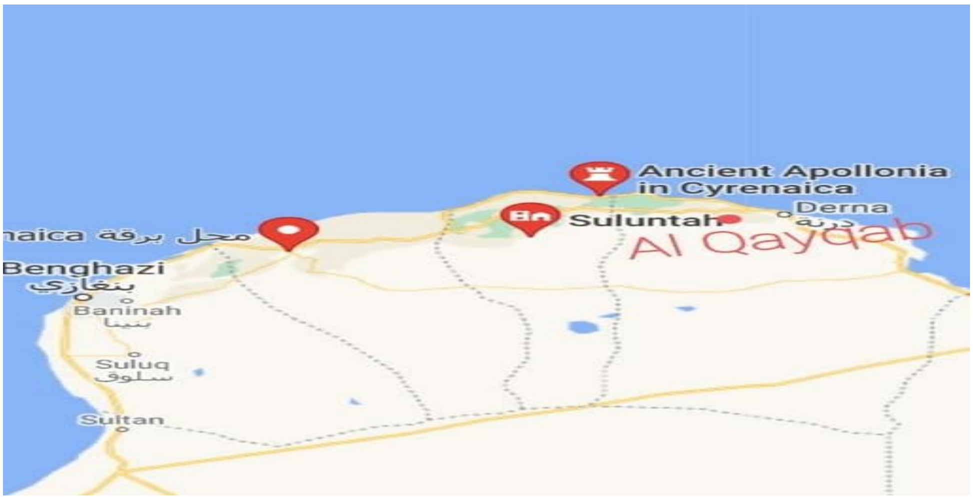

Figure 1 Location of Al Qayqab in Libya(source: Google map)

2. **Sampling**

El-Ghegab is a rural town; people mainly depend on wells as the primary source of drinking water. Water is pumped from wells into collective towers where treated. Afterward, water is forced into the distribution network of supply. However, many residents who live in separated and scattered homes; are not connected to a network of water supply. Therefore, springs make a secondary source of drinking water on many occasions, especially in many parts of the town that have a shortage of drinking water because of the lack of a pipe network or shortage of power to operate pumps. Accordingly, many inhabitants in the suburbs of Al Qayqab use springs for drinking and other daily

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activities such as washing, irrigation, and drinking for the animals. In the town, there are main two springs, one located in the east of the town and another in the west part.

3. **Time of sampling:**

The samples of water were collected in August 2020 between 6:00 pm to 6:30 pm to avoid extreme heat; when the sun temperature is moderate to avoid any unpredictable changes in the characteristics of the samples. We choose August because this time of year; the demand for drinking water is increasing dramatically as a result of a deficit in the public network of drinking water supply from a shortage of electricity because of excessive temperatures in this time of year.

4. **Collection of samples:**

A total of 10 samples were collected; 5 samples from each spring. The eastern and western springs were labeled with (A) and (B) respectively. Samples were collected from the eyelet (opening from which water oozes) of the spring. Each sample was collected into a 25 ml sterile polyethylene bottle. The sampler was taking water with the right hand and recapping the bottle with the left one. The hands of the sampler were treated with a sanitizing agent right before sampling to avoid any accidental contamination. The samples had been kept in dark bags to avoid exposure to extreme lights which may affect the samples. The samples were delivered to the laboratory of the Faculty of Public Health, University of Benghazi within 12 hours for analysis. Samples were kept in the refrigerator to avoid any microbial growth until the analysis was finished. Table 1 indicates the methods of analysis for target parameters.

Table 1 Methods of analysis

Parameter	Unit	Methods of analysis
PH		PH meter
Turbidity	NTU	Turbidity meter
TDS	mg/l	Filtration
Sodium	mg/l	Flame photometric method

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Potassium	mg/l	Flame photometric method
Lead	mg/l	Atomic absorption spectrometry (AAS)
Cadmium	mg/l	Atomic absorption spectrometry (AAS)
Arsenic	mg/l	Atomic absorption spectrometry (AAS)
Mercury	mg/l	Atomic absorption spectrometry (AAS)
Microbial analysis	CFU/ml	Cultivating on nutrient agar and incubated

5. Data analysis:

Statistical analysis was carried out by using the Statistical Package for Social Sciences (SPSS) (spss version 16.00) program, adopting the significance level of 5%. The mean values of the samples analysis were compared using a t-test for equality of means (independent samples test) to compare of means of acidity, total dissolved solids (TDS), concentration of sodium(Na), concentration of potassium(k), and total count of bacteria in both springs. chi-square (Mann-Whitney Test) to compare mean values of turbidity and E coli

Results and Discussion

The availability of water constituents is affected by many factors such as weathering, geographical factors including the type of the rocks, and human activities (10). Based on the physic-chemical analysis of samples taken from spring A: the examinations of parameters showed that measurements of pH, TDS, Turbidity, Na, and k ranged from 7.9-8.4 mg/l, 80-268 mg/l, 0-1NTU, 33-79 mg/l, and 9-25 mg/l respectively. Regarding to polluting heavy metals including lead, cadmium, arsenic, and mercury measurements are < 0.005mg/l,< 0.003mg/l, < 0.01mg/l, and < 0.001mg/l respectively. The results of total coli form counts and E coli ranged from 30-204 cfu/ml and 17-200 cfu/ml respectively as indicated in Table **2** Concentrations of physic-chemical, bacterial parameters, and heavy metals in springs A Table 2

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Table 2 Concentrations of physic-chemical, bacterial parameters, and heavy metals in springs A and B

Samples of East Spring (A)	S1	S2	S3	S4	S5
PH	8.3	8.1	8.4	7.9	8.08
TDS	124 ppm	80 ppm	245 ppm	268 ppm	198 ppm
Turbidity	0 NTU	0 NTU	0 NTU	0 NTU	1 NTU
Lead	< 0.005 ppm	< 0.005 ppm	< 0.005 ppm	< 0.005 ppm	< 0.007 ppm
Cadmium	< 0.003 ppm	< 0.003 ppm	< 0.003 ppm	< 0.003 ppm	< 0.003 ppm
Arsenic	< 0.01 ppm	< 0.01 ppm	< 0.01 ppm	< 0.01 ppm	< 0.01 ppm
Mercury	< 0.001 ppm	< 0.001 ppm	< 0.001 ppm	< 0.001 ppm	< 0.001 ppm
Sodium	58 ppm	33 ppm	79 ppm	69 ppm	55 ppm
Potassium	15 ppm	9 ppm	20 ppm	25 ppm	18 ppm
Total coliform count	204 cfu/ ml	85 colony /ml	100 colony/ml	30 cfu/ml	78 cfu/ml
E coli	200 cfu/ml	65 cfu/ml	22 cfu/ml	17 cfu/ml	35 cfu/ml
Samples Western spring(B)	**S6**	**S7**	**S8**	**S9**	**S10**
PH	7.8	8.3	8	7.9	8.5
TDS	186 ppm	160 ppm	223 ppm	271 ppm	192 ppm
Turbidity	0 NTU	0 NTU	0 NTU	0 NTU	0NTU
Lead	< 0.005 ppm	< 0.005 ppm	< 0.005 ppm	< 0.005 ppm	< 0.007 ppm

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Cadmium	< 0.003 ppm	< 0.003 ppm	< 0.003 ppm	< 0.003 ppm	< 0.003 ppm
Arsenic	< 0.01 ppm	< 0.01 ppm	< 0.01 ppm	< 0.01 ppm	< 0.01 ppm
Mercury	< 0.001 ppm	< 0.001 ppm	< 0.001 ppm	< 0.001 ppm	< 0.001 ppm
Sodium	70 ppm	52 ppm	65 ppm	81 ppm	52 ppm
Potassium	10 ppm	8 ppm	11 ppm	12 ppm	9 ppm
Total count	No growth	No growth	No growth	No growth	No growth
E coli	No growth	No growth	No growth	No growth	No growth

ppm is equivalent to mg/ l, * Total coliform count and E coli standards provided by the lab according to Libyan standards is 0

Table 2 also indicated the results of the assessment of samples taken from spring B, physic-chemical measurements of parameters pH, TDS, turbidity, Na, and k ranged from 7.8-8.5, 160-271mg/l, 0 NTU, 52-81mg/l, and 9-12mg/l respectively. The microbial analysis of samples showed no colony growth for total coli form count nor E coli in all the samples. Concerning heavy metals all the concentrations of lead, cadmium, arsenic, and mercury measurements are < 0.005mg/l,< 0.003mg/l, < 0.01mg/l, and < 0.001 respectively as presented in Table 3

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Table 3 Average, minimum, and maximum values of parameters of springs A and B

Statistics of Spring A							
Parameters	pH	TDS	Turbidity	conc of sodium mg/l	conc of potassium mg/l	total coliform count (cfu)	E coli (cfu)
Mean	8.17	183	.20	58.8	17.4	99.4	67.8
WHO	6.5-8.5	600-1000	<1	50	--------	Not detected	Not detected
Std. Deviation	.196	79.66	.44	17.26	5.94	64.07	76.22
Minimum	7.90	80	.0	33	9	30.00	17.00
Maximum	8.40	268	1.0	79	25	204.00	200.00
Statistics of Spring B							
Parameters	pH	TDS	Turbidity	conc of sodium mg/l	conc of potassium mg/l	total count cfu/ml	E coli cfu/ml
Mean	8.1	206.4	.0	64	10	.0	.0
WHO	6.5-8.5	600-1000	<1	50	--------	Not detected	Not detected
Std. Deviation	.291	42.5	.0	12.38	1.58	.0	.0
Minimum	7.8	160	.0	52	8	.0	.0
Maximum	8.5	271	.0	81	12	.0	.0

PH is considered one of the most valuable factors in water quality. It is the measure of acidity and alkalinity of water (9). The average values of pH for both springs are acceptable because they fall within the range set by the WHO Table 4. The results of pH in all samples at both springs ranged from 7.8 to 8.5 as indicated in Table 3 and Table 4; therefore, all the water samples are moderately neutral to almost alkaline. Besides, statistical analysis did not present a significant difference ($p > 0.05$) among pH measurements for both springs. Similarly, a study was conducted in Arbaminch, Ethiopia on springs; pH measurements in the samples were acceptable (11). Accordingly, the

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samples are considered almost neutral which comes in accordance with (12) and another study made by (10)

The obtained average turbidity in both springs A and B with mean values 0-0.2 NTU were within the permissible limits as shown in Table 4. According to the results of the samples; the springs were not cloudy, indicating the absence of suspended particles; which may come from soil runoff (13).

TDS are mainly inorganic matters and small amounts of organic matter; found in the form of a solution in water (14). The mean TDS values of samples from both springs are below the acceptable range set by WHO; since the average values of springs A and B were 183 mg/l and 206.4 mg/l respectively. However, the comparison of springs A and B, in terms of physical characteristics including pH, Turbidity, and TDS, showed no significant difference($p > 0.05$) between the two springs.

As presented in Table 4, the average concentrations of sodium are 58.8 mg/l for spring A and 64 mg/l for spring B. Both are moderately higher than the guidelines for WHO. In many countries, sources of drinking water contain less than 20 mg/l of sodium minerals, while in other nations the quantity in drinking water exceeded 250 mg/l. The proper amount of sodium inside the body will protect against many health problems such as kidney damage, headaches, and hypertension (2).

On the other hand, the results of our study showed that concentrations of potassium ranged from 9-25 mg/l in samples of the eastern spring and 8-12 mg/l in the western spring Table 3. Similarly, a study conducted in many regions in Ethiopia on springs showed that the maximum concentrations of both sodium and potassium are less than 40 mg/l (2). However, no significant difference ($p > 0.05$) in the concentrations of sodium and potassium in both springs.

Pb, As, Cd, and Hg were not detected in all samples as depicted in Table 2. Recently, global public health concerns have been increasing related to contamination by major and trace metals (15). Baby and J Bose measured the concentrations of many heavy metals including lead and cadmium in nine spring water sampling locations next to Simour district of Himachal Pradesh in India; the concentrations of heavy metals; were found

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less than permissible limits, indicating the fact the springs are not contaminated (16). On the other hand, the researcher conducted a study in several locations near industrial and mining areas in Kosovo, to assess the concentrations of heavy metals such as arsenic and lead in springs at 15 sites from April to October 2019, the evaluated samples revealed high concentrations of lead and arsenic, pointing to pollution of springs, which can affect negatively of the health of peoples consuming spring water in those locations (17).

Since water is fundamental to human life, accessible water, which is microbial, physical, and chemical safe, is important to human health. Globally 1.1 billion persons are still using water polluted with fecal micro-organisms. Detection of pathogenic microorganisms in water is complicated. Accordingly, the test was developed by the International Organization for Standardization (ISO) for microbial water quality. This test is based on the detection of certain bacteria presented as indicators for fecal contamination which are most widely used for this purpose are total coli form and E coli (7).

The results in Table 3 showed high contamination of raw water in spring A with a mean concentration of 99.4 cfu/ml for total coli form and 67.4 cfu/ml for E coli. The presence of such bacteria in the spring indicates evidence of current fecal contamination; therefore, further action should be taken such as more sampling and evaluation of this spring. *Escherichia coli* lives normally inside the intestines of human bodies and animals as well (18). The microbial analysis revealed alarming growth for fecal micro-organisms; however, the E coli and total coli forms should not be detectable according to WHO's guidelines as well in drinking water. Water-transmitted outbreaks are usually related to polluted water sources (6). Thus, a significant difference among E coli and total coli forms of both springs A and B ($p < 0.05$) by applying the Mann-Whitney Test. Accordingly, the water of Eastern Spring (A) should not be consumed as a drinking water source.

Table 4 Mean concentration values of parameters of Eastern and Western springs compared with WHO standards

Parameter	Spring A(Mean value)	Spring B (Mean value)	WHO
pH	8.17	8.1	6.5-8.5

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TDS (mg/l)	183	206.4	600-1000mg/l
Turbidity (NTU)	0.20	0	1-4 NTU
Sodium (mg/l)	58.8	64	50 mg/l
Potassium (mg/l)	17.4	10	-----
Total coliform count(colony/ml)	99.4	0	Should not detected
E coli(colony/ml)	67.8	0	Should not detected

Conclusion

The results of our investigation suggested raw spring waters in both eastern and western locations in Al Qayqab, are physico-chemically accepted and mostly fall within the ranges of WHO permissible limits and we did not detect any contamination with heavy metals of lead, mercury, cadmium, and of arsenic. The biological assessment showed the water in the eastern spring is highly contaminated with fecal micro-organisms; indicating the presence of fecal pollution. We recommend not using the water as a source of drinking and more investigation over seasons including more chemical and physical parameters in the future.

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Conflict of interest

The authors declare there is no conflict of interest in publishing the article.

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