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ASSESSMENT OF RAINWATER QUALITY FROM COLLECTED RAINWATER AND ITS TREATMENT NEEDS IN DIFFERENT AREAS IN THE ALJABIL ALAKHDER

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ABSTRACT
Rain water samples were collected from three cities, Al-Bayda, Shahat and Derna. A study was conducted to evaluate the level of quality of rainwater by tested pH, Electrical Conductivity (EC) , total dissolved solids (TDS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Turbidity, Fe^{+2} and pb^{+2}. The results showed that the range of reading for were pH from 6.42 until 7.24, EC from (57.2 -484) microsiemens/cm^3 ,TDS between 27 and 231 mg/L, COD was 4.09 mg/ L-8.32mg/L and BOD was ranged 1-55 mg/L and 3.24 mg/L. The range of parameter of Turbidity readings were between 6.23-9.84NTU, Fe^{+2} was ranged 0.030 mg/l and 0.058 mg/L and the pb^{+2} was from 0.0020mg /L to 0.0057 mg/L. The comparison with Recommended Raw Water Criteria by World Health Organization (WHO) shows that within the permissible limits.

Keywords: Rainwater, Heavy metals, Quality, Assessment, Rooftop, Treatment, Aljabil Alakhder.

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تقييم جودة مياه الأمطار من مياه الأمطار المتجمعة واحتياجات معالجتها في مناطق مختلفة بالجبل الأخضر

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المخلص

تم جمع عينات مياه الأمطار من ثلاث مدن هي البيضاء وشحات ودرنة. أجريت دراسة لتقييم مستوى جودة مياه الأمطار عن طريق اختبار درجة الحموضة والتوصيل الكهربائي والعكارة والمواد الصلبة العالقة والطلب على الأكسجين البيولوجي والكيميائي وعنصري الحديد والرصاص. أظهرت النتائج أن نطاق القراءة للأس الهيدروجيني من 6.42 حتى 7.24، التوصيل الكهربائي من (57.2 –484) ميكروسيمنز/سم3، المواد الصلبة الذائبة بين 27 و231 ملغم/لتر، COD كان 4.09 ملغم/لتر–8.32 ملغم/لتر وكان BOD تراوحت بين 1–55 ملغم/لتر و3.24 ملغم/لتر. كان مدى معامل قراءات العكارة بين 6.23 – 9.84 NTU، وتراوح Fe^{+2} بين 0.030 ملجم/لتر و0.058 ملجم/لتر وpb^{+2} من 0.0020 ملجم/لتر إلى 0.0057 ملجم/لتر. وتظهر المقارنة مع معايير المياه الشرب الموصي بها من قبل منظمة الصحة العالمية (WHO) أنها ضمن الحدود المسموح بها.

كلمات مفتاحية: مياه الأمطار، المعادن الثقيلة، الجودة، تقييم، مياه السطح، معالجة، بالجبل الأخضر

1. INTRODUCTION

Water is one of the important issues nowadays. Currently, 1 in 10 lack access to safe water, and as an alternative to solve the water crisis in the future a rainwater harvesting system. When dealing with rainwater applications, two important aspects that must be taken into account which are, water quality requirements and potential uses.

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Due to the importance of collected rainwater especially towards sustainable future, rainwater harvesting and its quality are the focal point of on-going research [1].

Rainwater can be used for a many of household purposes, including cleaning, sanitary facility flushing, laundry, car washing, as well as lawn and crop watering. In Kenya and Bangladesh where are exposed to high risk of water deficit, rainwater is also considered as water intended for consumption [2]. So, the testing of rain water is crucial for the protection of public health. While in generally rainwater had been believed that is relatively clean, but test results show that it is physically, chemically, and microbiologically polluted [3, 4].

The characteristics quality of harvested rainwater is determined by significant variability in both space and time. The composition of rainwater is dependent on many factors, such as atmospheric pollution (including the presence of dust, pollen, and bioaerosols), the type of catchment, land use (industrial areas and roads and highways), the local microclimate, and the type of the runoff surface (various roof pitches and various roofing materials).Rainwater contamination reaches the highest levels in urban areas, which is mainly linked to the emissions of power plants, local boiler plants, and industry [5, 6]. The large extent, substances that are washed out of the atmosphere is the source of rainwater pollution, but the greatest pollution occurs in rainwater that flows down the surface of terrains, roofs, gutters, or pipeline networks [7].

The quality of water is a very important factor with regards to the possible options for its economic utilization, although the highest quality (that is, the quality that meets the standards for consumption and hygienic applications) is not always required for such utilization. Rainwater can be a carrier of pollution that gets into surface water and soil. The impact of rainfall may be partly explained by researching the quality of these resources, such as the condition of water in water reservoirs [8].

The Samples of rain water have been collected in different sites in lat takia, Syria. The pH results were (7.1-7.8) which indicates the alkaline nature. During spring the concentration of sodium, sulfates,

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ammonium, chloride is more than that other marked and in the concentration of Magnesium and ions Calcium no significant differences of the target precipitation [9].

The chemical and physical properties of rainwater were studied in Khomes city, Libya. The results have been found within the international standard, but in two regions namely Merghib and Sellen area the cadmium concentration was above the allowed limit. Bicarbonate, sulfate and chloride represent (>50%,<30%,<45%) respectively and the ratio of calcium and magnesium are between (40-50%) [10].

Rain water samples were collected from four tanks presented in four areas of Misurata, Libya. Physicochemical parameters such as temperature, conductivity, total dissolved solids (TDS) and pH, and four heavy metals, viz., Fe, Cu, Pb and Cd were analyzed. The concentrations of the heavy metal ions and the investigated physical and chemical properties in the rain water samples have been found below the guidelines for drinking waters given by the World Health Organization (WHO) [11].

2. MATERIALS AND METHODS

2.1. STUDY AREA

The research was carried out from December 2021 to February 2022 in area located in Shahat city and Darnah city which are within the coordinate latitude of (32°49′00″N -32°46′00″N) and longitude of (21°51′00″E-22°38′00″E) respectively. The population census of each of them shall be 117161, 63000 and 130481 consecutively.

2.2. COLLECTION OF RAIN WATER SAMPLES

18 samples had been taken in three months December, January and February. The samples were taken from the 3 stations, two ways to take samples for each area in studying time. One of them was collected directly and another was from the house roofs. After collection, rain water samples were transferred without any treatment into clean 5-L bottles, tightly covered by caps and then stored in laboratory.

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2.3. SAMPLE ANALYSIS

The parameters involved in this study were pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Turbidity, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Iron (Fe), and Lead (Pb). The heavy metals were determined by Atomic Absorption Spectrometer (AAS). The selected physical, chemical rainwater parameters and heavy metals were determined according to applicable raw water criteria by World Health Organization (WHO).

3. RESULTS AND DISCUSSION

3.1. PHYSICAL AND CHEMICAL PROPERTIES OF THE SAMPLES

The resulting values of pH, , Turbidity, EC, TDS, COD and BOD parameters were measured to evaluate the suitability for non-potable purpose, the results have been given in table(1A- 1B).

Table (1A):- The resulting values of Physical and Chemical Properties of the samples.

	Month	PH direct	pH roof	TDS direct	TDS roof	EC direct	EC roof
Darnah	12	6.68	6.97	103	127	210	267
	1	6.74	6.42	110	231	221	484
	2	6.75	6.41	112	233	225	488
Shahat	12	6.7	7.05	27	64	57.2	135.2
	1	6.9	7.12	50	118	107	250
	2	6.84	7.24	63	62	129.5	132.8
AlBayda	12	6.6	6.79	30	36	63.6	75.4
	1	6.83	7.08	47	51	99.4	107
	2	6.83	7.12	57	60	105	110

Table (1B):- The resulting values of Physical and Chemical Properties of the samples.

	Month	BOD direct	BOD roof	COD direct	COD roof	Turbidity direct	Turbidiy roof
Darnah	12	2.53	3.12	4.12	7.52	6.23	7.97
	1	1.72	2.41	4.77	5.81	6.91	7.66

	2	1.8	2.46	4.79	5.9	6.93	7.7
Shahat	12	1.92	2.67	4.36	5.89	6.44	8.65
	1	1.97	3.02	4.64	7.49	6.8	8.07
	2	1.55	2.87	5.47	8.32	7.82	8.13
AlBayda	12	2.57	3.24	4.09	7.65	7.01	9.26
	1	1.76	2.59	4.23	6.32	6.61	9.84
	2	1.9	2.5	4.2	6.3	6.6	9.7

3.1.1 . pH

PH of the rain water from direct were varying from (6.6 -6.83), (6.70 -6.94) and (6.68 – 6.74) in Al Bayda , Shahat and Derna consecutively. The pH readings for rainwater from the roofs were between (6.79 – 7.08) in Al Bayda, in Shahat were PH from 7.05 until 7.24 and in the last station the value were (6.42 – 6.97).From these results, it can observe that the values of pH in all stations are within the limits prescribed by WHO.

3.1.2. ELECTRICAL CONDUCTIVITY (EC)

The highest values of electrical conductivity have found in Derna are 484 microsiemens/cm^3 for rainwater from the roof and 221 microsiemens/cm^3 for direct rainwater. The lowest values for the roof rainwater were in Al Bayda samples, which is 75.4 microsiemens/cm^3, while the direct rainwater for electrical connection in Al Bayda and Shahat were 63.6 microsiemens/cm^3, and 57.2 microsiemens/cm^3 respectively.EC all fall within the permissible limits of the World Health Organization (WHO) drinking water quality guidelines.

3.1.3. TOTAL DISSOLVING SOLIDS (TDS)

The total dissolved solids in rain water have recorded for the surface and direct water of the Al Bayda was 51 mg/L and 47 mg/L, respectively. Shahat had the TDSt value of 118 mg/L for surface water, and direct rainwater had a value of 62 mg/L. While the highest values were obtained in Derna, 484 mg/L for surface water and 221 mg/L for direct water. The WHO has suggested a limiting value of 500 mg/l of TDS for potable water. In the present investigation, this limit is not crossed on any of the samples under study.

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3.1.4. TURBIDITY

The results of the study obtained showed that the highest value in water collected from the surface was found in the sample of Al Bayda (NTU 9.84) and the highest direct water was (NTU 7.82) in Shahat. While the lowest values obtained from the Derna city sample, whether direct water or rain water are (NTU7.97 - NTU6.91), respectively. By comparing the results with the World Health Organization specifications for drinking water, the turbidity is higher than its limits (NTU5).

3.1.5. BIOCHEMICAL OXYGEN DEMAND (BOD)

Convergence in values was observed in all locations, where the highest results were in surface water samples for the city of Al-Bayda, Shahat, and Derna (3.24 - 3.02 - 3.12 mg/L), and the lowest (2.59- 2.67-2.41 mg/L), respectively. Likewise, in direct water, the highest values were (2.57 - 1.97 - 2.53 mg/L) and the lowest values (1.76 - 1.55-1.72 mg/L) were in the samples of Al Bayda, Shahat, and Derna, respectively. The results did not show any increase in biological oxygen values beyond the permissible limit according to WHO.

3.1.6. THE CHEMICAL OXYGEN DEMAND (COD)

The table shows that the oxygen demand values in the samples of Shahat city were the highest, as its value was found in surface water to be 8.32 mg/L and in direct water to be 5.47 mg/L, while the lowest values were in surface water and direct water in Derna (7.52 mg/L - 4.77 mg/L) respectively. The results showed that the chemical oxygen demand in the surface water of Al Bayda was the highest (7.65 mg/L) and the lowest (6.32 mg/L), while the highest value in the direct water was (4.23 mg/L) and the lowest (4.09 mg/L). It was found that all the results obtained fell within the limits prescribed by WHO.

3.2 HEAVY METALS

3.2.1. IRON (II)

Fe^{+2} concentration readings range in roof rain were between (0.037 mg/L - 0.045 mg/L), (0.040 mg/L - 0.045 mg/L) and (0.056 mg/L -

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0.058 mg/L) of Al Bayda, Shahat and Derna consecutively. While in direct rain water the concentration readings range in Al Bayda were (0.030 mg/L and 0.038 mg/L), in Shahat were (0.037 mg/L and 0.040 mg/L) and readings in Derna were (0.034 mg/L and 0.038 mg/L). In general, the concentration of iron in collected samples from different areas fall well within approved limit by WHO. The results have been given in table (2).

Table (2) :- The results of the analysis of lead and iron .

Station	Month	Fe direct	Fe roof	Pb direct	Pb roof
Darnah	12	0.0337	0.05837	0.00391	0.00481
	1	0.03811	0.05609	0.00214	0.0056
	2	0.03812	0.05616	0.00218	0.0057
Shahat	12	0.04076	0.04219	0.00358	0.00383
	1	0.03383	0.04458	0.00259	0.00315
	2	0.03701	0.04033	0.00311	0.00409
AlBayda	12	0.03813	0.04511	0.00284	0.0048
	1	0.03048	0.03693	0.00194	0.0039
	2	0.03111	0.03701	0.00204	0.0041

3.2.2. LEAD (II)

The results of the analysis of lead in the Al Bayda have contended varies from 0.0020 mg/L to 0.0029 mg/L in direct rain water, whilst in roof rain water sample were (0.0039 mg/L - 0.0048 mg/L). The highest value in direct rain water was 0.0036 mg/L and in roof rain water was 0.0041 mg/L in Shahat samples, but the lowest values were 0.0026 mg/L - 0.0032 mg/L respectively. In Derna concentration readings range in roof rain were between (0.0048 mg/L - 0.0057 mg/L) and in direct rain water were from 0.0022 mg/L to 0.0039 mg/L. pb^{+2} concentrations in the all waters samples ، were low and in the limits approved by WHO. The results have been given in table (2).

4. CONCLUSION

In regard of pH, TDS, COD, BOD, Turbidity and EC in the rain water samples from Al-Bayda city, Shahat and Darnah were found below the guidelines for drinking waters given by the World Health

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Organization (WHO).Also and the concentrations of the heavy metal ions (Fe and Pb) in collected samples from different areas fall well within approved limit by WHO).For the conclusion, it can be said that rainwater can be used as the raw water in study areas.

REFERENCES

[1] Muhamad, MA b, Abidin M Z. Water Quality Assessment of Rainwater Collected from Rooftop at UTM.Universiti Teknologi Malaysia, Malaysia. 2016.

[2] Evans CA, Harrison T, Coombes PJ, Dunstan HR, Dunstan RH. Identifying the major influences on the microbial composition of roof harvested rainwater and the implications for water quality. Water Sci. Technol. 2007, 55, 245–253.

[3] Zdeb M., Zamorska J, Papciak D. Studying microbiology of rain water for of their use in economy. J. Ecol. Eng. 2016, 17, 203–208, doi:10.12911/22998993/63314.

[4] Gwezi, W, Dunjana N, Pisa C, Taur OT, Nyamadzawo G. Water quality and public health risks associated with roof rainwater harvesting systems for potable supply: Review and perspectives. Sustain. Water Qual. Ecol. 2015, 6, 107–118.

[5] Friedler E, Gilboa Y, Muklada H. Quality of Roof-Harvested Rainwater as a Function of Environmental and Air Pollution Factors in a Coastal Mediterranean City (Haifa, Israel). Water 2017, 9, 1–12, doi:10.3390/w9110896.

[6] Despins C, Farahbakhsh K, Leidl C. Assessment of rainwater quality from rainwater harvesting systems in Ontario, Canada. J. Water Supply Res. Technol. AQUA 2009, 58, 117–134, doi:10.2166/aqua.2009.013.

[7] Helmreich B, Horn H. Opportunities in rainwater harvesting. Desalination 2009, 248, 118–124.

[8] Koszelnik, P. Atmospheric deposition as a source of nitrogen and phosphorus loads into the Rzeszow 5 reservoir, SE Poland. Environ. Prot. Eng. 2007, 33, 157–164.

تم استلام الورقة بتاريخ: 3/ 4/2024م وتم نشرها على الموقع بتاريخ: 30/ 4/2024م

[9] Hussien M M, Kbibo I N, Hayfa SA. Study of the chemical characteristics of rain water in different sites in Lattakia. Tishreen .University Journal for Research and Scientific Studies - Biological Sciences Series 2013, Vol. 35 No. (6)

[10] Besbso N K. , Al-Dawfani LBO. Study of the physical and chemical properties and heavy metals of rainwater in Al-Khums area. Science and Technology Journal. 2016.

[11] .Mayouf J A . Determination of Iron, Copper, Lead and Cadmium Concentrations in Rain Water Tanks in Misurata, Libya. ARPN Journal of Science and Technology. 2012 VOL. 2, NO 8.