Life Science Journal

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Multidisciplinary Academic Journal Publisher

Microbial, physical and chemical analysis of well water in Al-Leith city, Saudi Arabia. 2023- 2024.

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Abstract: Water samples from wells in Al-Lith, Makkah Al-Mukarramah, were analyzed, the water quality analysis revealed that the turbidity, chlorine concentration, total water hardness, and nitrate concentration in the samples varied, with some exceeding acceptable limits. The pH, iron, copper, fluoride, and ammonia concentrations were within acceptable limits. To improve water quality, measures should be taken to address turbidity, chlorine concentration, total water hardness, and nitrate concentration. Additional purification steps and bacteriological tests are recommended. Users should be educated about using safe water, and regular monitoring and evaluation of water quality by authorities are crucial for ensuring clean and safe water availability. Consulting water treatment experts is advised for implementing appropriate measures.

[Anas S Dablool, Nayef Shabbab Almutairi, Mohannad Salah Kalkatawi, Adnan Y Albarakati, Naif S Alharazi, Abdulrahman Almalki, Muhannad F Almaliki , Wesam Aljubayri , Saud Almdawsi , Bandar Alhaily*, Makki A Digna , Razaz A Qammash , Jehad A Bifari, *Microbial, physical and chemical analysis of well water in Al-Leith city, Saudi Arabia. 2023- 2024. Life Sci J* 2024;21(4):29-34]. ISSN 1097-8135 (print); ISSN 2372-613X (online). http://www.lifesciencesite.com.04. doi:10.7537/marslsj210424.04.

Keywords: Water samples, Wells, Water quality analysis, Turbidity.

1. Introduction:

The quality of groundwater has deteriorated due to increased global utilization of groundwater resources, leading to contamination[1]. In the Kingdom of Saudi Arabia (KSA), groundwater plays a crucial role in meeting the demand for drinking water and irrigation. Over the past three decades, groundwater extraction in KSA has significantly increased, reaching a volume of 17 billion m3/year. About 80% of the water supply in KSA comes from groundwater sources. However, the annual recharge of groundwater is considerably low compared to the rate of withdrawal [2], resulting in declining groundwater levels and affecting its quality.

The Arabian shield, characterized by deep aquifers in sedimentary formations, consisting of a thick sequence of Paleozoic to recent sedimentary deposits, serves as a major source of groundwater in the region. These aquifers develop secondary porosities overlying the fractured Precambrian basement. Additionally, the shallow aquifers present in valleys also contribute significantly to water supply in the Arabian shield and coastal regions. The region's climate is predominantly arid to semi-arid, and the groundwater resources face extreme stress due to high temperatures, low and unpredictable rainfall, and high evapotranspiration rates [3].

While groundwater resources were primarily used for agriculture in the 1970s, rapid urbanization, industrial growth, and population increase have shifted the focus, raising concerns about the quantity and quality of groundwater in an already water-stressed region. The deterioration in groundwater quality can be attributed to both anthropogenic sources and natural/geogenic sources[4].

Well water is considered one of the most important vital sources of water in the Kingdom of Saudi Arabia. Saudi Arabia is distinguished by its abundant underground resources that meet a large part of the country's water needs. Well water is an important source of fresh water and is used for a wide range of uses including drinking, agriculture and industry.

Water wells are distributed throughout the Kingdom, including deep wells in desert areas and shallow wells in areas located in depressions and valleys. The characteristics of well water in Saudi Arabia vary

depending on the geographical area and the surrounding geological formations. The properties of water range in terms of alkalinity and the salts and mineral elements present in it.

However, well water in Saudi Arabia faces several challenges. Some wells may contain natural contaminants or as a result of human contamination, affecting their quality and usability. Excessive use of well water can cause drought and a drop in the water table. Therefore, efforts need to be directed towards improving the quality of well water and maintaining the sustainability of water resources in the Kingdom.

This project aims to contribute to improving the quality of well water in the region. By studying and analyzing water samples and evaluating potential sources of contamination, the team will work to identify specific issues affecting groundwater quality in the area. Improvement efforts will include proposals to develop and implement procedures and technologies to treat and purify affected groundwater. In addition, the project also aims to study and document the characteristics of groundwater in the region.

2. Literature Review:

A study was conducted on water quality in 388 wells across 6 regions in Saudi Arabia. Parameters such as pH, total dissolved salts (TDS), nitrite, ammonium, nitrate, and fecal coliforms were analyzed. TDS concentrations ranged from 180 to 9350 mg/L, with an average of 754 mg/L. 18.6% of the wells (72 out of 388) exceeded the WHO limit of 1000 mg/L for TDS. Nitrate levels varied significantly, ranging from 0.0 to 95.2 mg/L, with an average of 20.7 mg/L. Around 7.7% of the tested wells had nitrate levels exceeding the WHO limit of 45 mg/L, and 16% had ammonium levels greater than 0.05 mg/L. Fecal coliforms were detected in 21.4% of the tested well water samples, indicating notable contamination with nutrients and fecal coliforms[5].

A study was conducted on well water samples from the Saq aquifer in the Qassim Region, Saudi Arabia, from 1997 to 2009. The samples were analyzed for various parameters. The electrical conductivity of the water increased gradually over time but remained within permissible limits for drinking water. The total water hardness indicated that the water was classified as very hard, requiring softening before domestic use. pH values were within the standard range for drinking water. Cations and anions followed a similar trend to electrical conductivity and were below permissible limits.

The fluoride concentration was below the recommended limit, necessitating fluoridation. The ammonium concentration exceeded the permissible limit, highlighting the need for treatment measures. Overall, appropriate treatment is necessary to ensure the suitability of well water in the studied region for domestic use[6].

Groundwater quality in Saudi Arabia faces challenges due to anthropogenic and geogenic sources of pollution. Industrial effluents, agricultural fertilizers, and domestic sewage contribute to groundwater pollution in the region. This review addresses the issues related to groundwater quality and assesses aquifer vulnerability to pollutants. The study focuses on parameters such as fluoride, nitrate, heavy metals, and radionuclides. The discharge of wastewater effluents is a significant contributor to aquifer contamination with heavy metals. Understanding these challenges is crucial for future research and addressing groundwater quality problems in Saudi Arabia[7].

3. Material and Methods:

Seven samples of well water were collected in Al-Layth Governorate. These samples were carefully selected to represent a diverse range of water sources in the area. Physicochemical tests were conducted to measure parameters such as pH, alkalinity, electrical conductivity, and temperature. Chemical tests were also performed to analyze the chemical composition of the water, including minerals and organic compounds. Finally, bacteriological tests were conducted to determine the presence and concentration of microbial organisms in the water.

The physical examination of water includes measuring its pH level and turbidity. pH indicates acidity or alkalinity, with a range of 0 to 14. Turbidity measures the clarity and presence of suspended particles in water.

The chemical examination involves testing for parameters such as ammonium, fluoride, copper, nitrate, chlorine, and heavy metals. These tests help assess water quality and detect potential contaminants.

Bacteriology tests, such as the coliform bacteria and Escherichia coli (E. coli) tests, are performed to determine the presence and concentration of bacteria in water. These tests indicate contamination with harmful bacteria.

To conduct the tests, water samples are collected and mixed with specific solutions. The samples are then incubated, and the growth of bacteria is observed. Positive results indicate bacterial contamination, while negative results indicate clean water.

Regular bacterial tests should be conducted to ensure water safety, and appropriate measures should be taken to purify contaminated water.

Water analysis plays a crucial role in preserving the environment and protecting human health.

4 Results

Chemical analysis													Physical analysis		
NH4 1.5	F 1.5	Cu 2	No2 3	So4 250	Fe 0.3	No3 50	Mg 250	Ca 200	T.H 500	CL.x 19.85 250	T.D.S 1000	PH 8.5-6.5	Turbidity 5	Ccnd	Sample
0.006	1.13	0.21	0.015	284	0.089	48.7	78.4	131.2	608	276	760	7.06	0.71	1556	1
0.001	1.06	2.58	0.024	326	0.088	46.5	11.6	270.4	716	289	820	7.15	0.16	1666	2
0.004	1.26	1.17	0.02	246	0.085	36.3	45.9	155.2	552	247	632	7.34	0.68	1302	3
0.617	1.25	4.46	0.031	394	0.087	14.2	12.32	321.6	848	656	1340	7.25	0.56	2680	4
0.008	1.55	3.79	0.051	344	0.086	173.2	36.9	316.8	660	346	1040	7.25	1.73	2100	5
0.001	1.25	2.58	0.021	267	0.082	89	37.1	201.28	636	271	762	7.42	0.59	1556	6
0.019	0.565	1.17	0.025	106	0.087	23.8	27.7	54.56	235	787	284	7.65	0.76	593	7

Table 1. A chemical-physical examination revealing distinctions among the specimens.

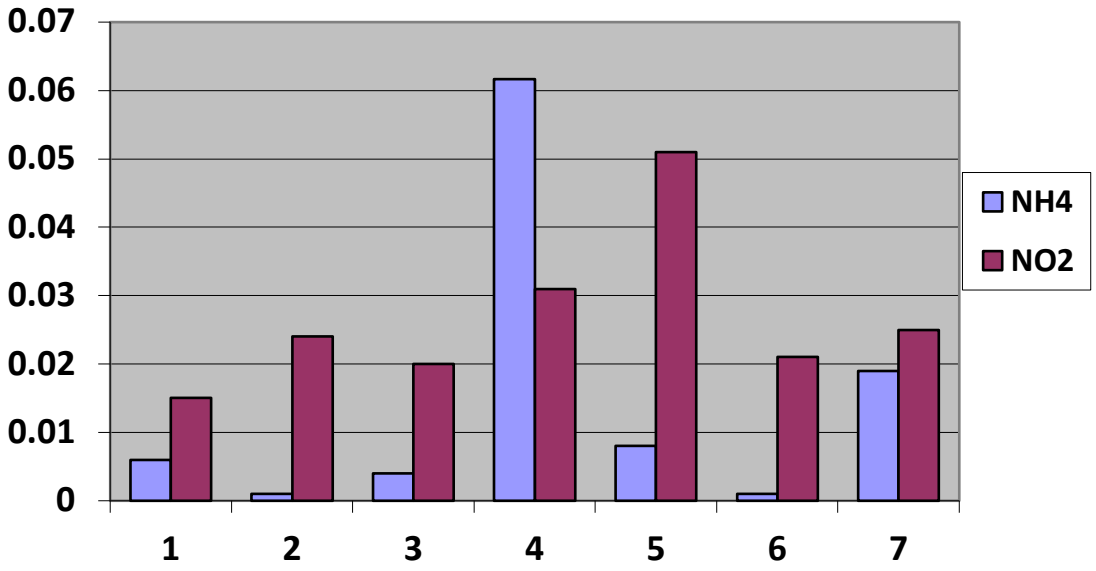

Figure 1. Shows the level of Ammonium and Nitrogen dioxide among the specimens

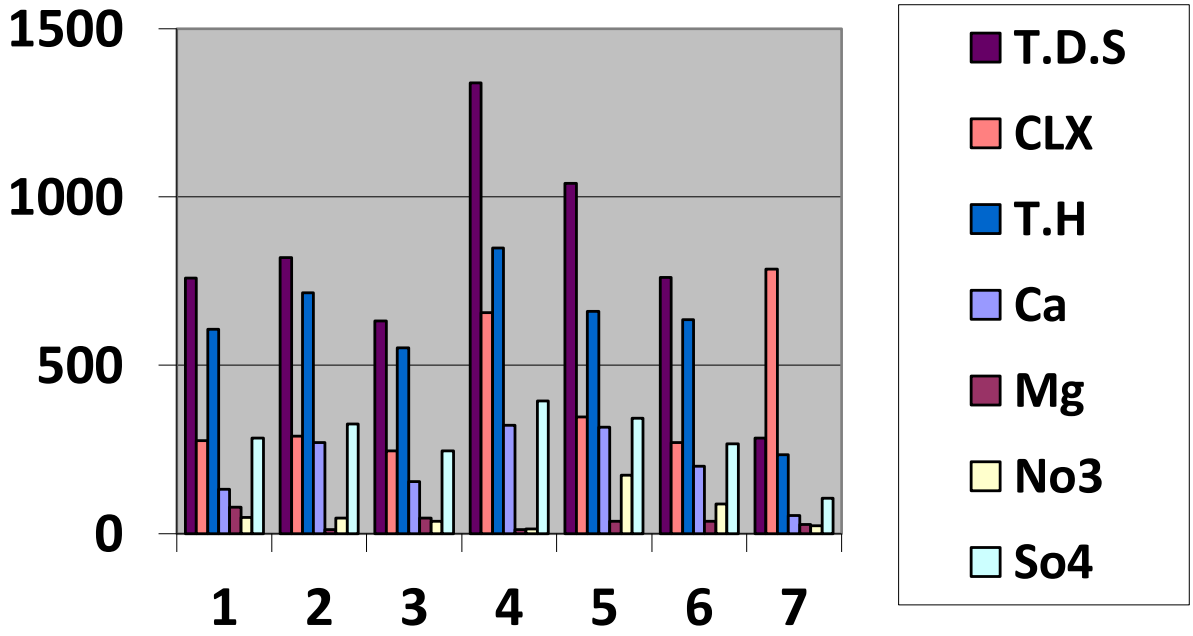

Figure 2. Compares the level of multiple cations and anions in the samples

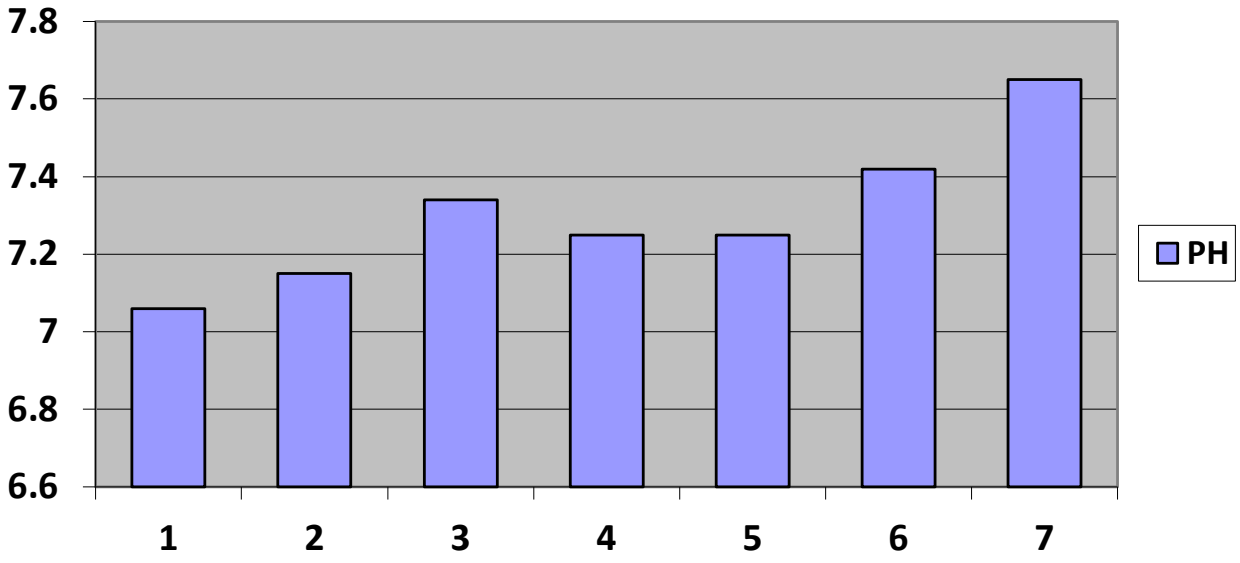

Figure 3. PH range among the samples

Table 2. Bacteriology Test showed most probable number as it's within low to medium risk, According to the WHO.

Number Of Sample	Code	Coliform	E. coli
1	134	>16.0 MPN/100ml	<2.2 MPN/100ml
2	135	2.2 MPN/100ml	2.2 MPN/100ml
3	136	2.2 MPN/100ml	2.2 MPN/100ml
4	137	>16.0 MPN/100ml	5.1 MPN/100ml
5	138	>16.0 MPN/100ml	<2.2 MPN/100ml
6	139	16.0 MPN/100ml	<2.2 MPN/100ml
7	140	2.2 MPN/100ml	<2.2 MPN/100ml

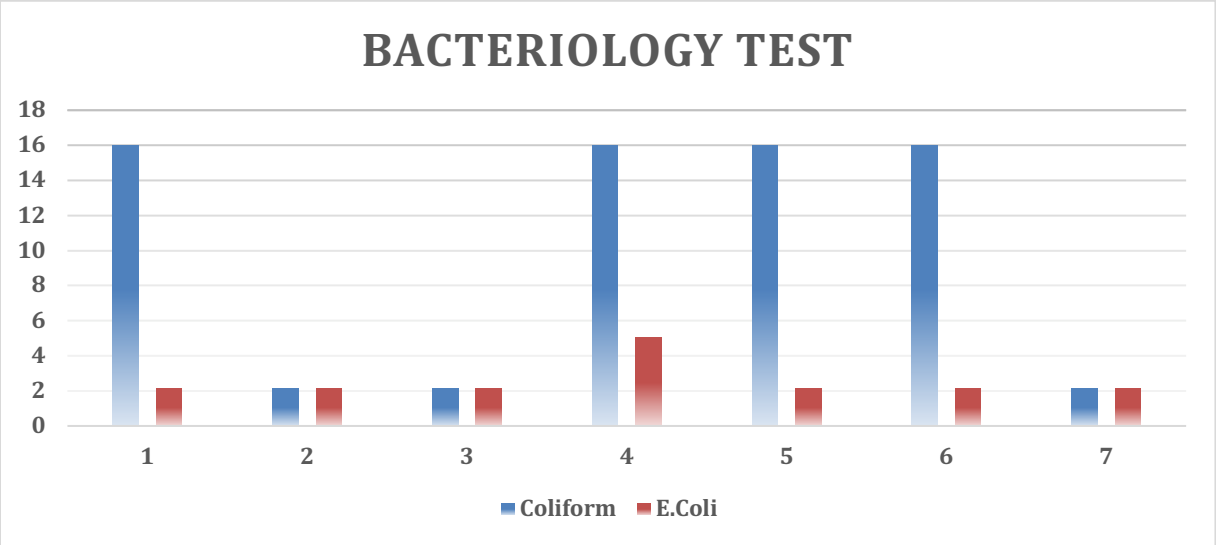

Figure 4. A follow up comparison for Bacteriology Test seven samples of well water

5. Discussion

The water samples were tested for turbidity in addition to temperature, electrical conductivity, alkalinity, pH, and other characteristics, all were measured using physicochemical assays. To examine the water's chemical composition, particularly its mineral and organic constituent content, chemical tests were also carried out. Lastly, to ascertain the quantity and existence of microorganisms in the water, bacteriological tests were carried out.

Within acceptable bounds, the samples' turbidity values span from 0.16 to 1.73 NTU. Water that is neutral is indicated by pH values between 7.06 and 7.65. Some samples have high T.D.S. values, which vary from 284 to 1340 ppm. The values of the chlorine concentration, which exceeds allowable limits, range from 247 to 787 parts per million. The findings for total hardness are considered unacceptable for domestic purposes, ranging from 552 to 848 ppm. Certain test subjects exhibited calcium concentrations that were the cause for alarm, escalating to of 321ppm. The magnitude of magnesium in the sample fell between 11.6 and 78.4 which is acceptable. Some samples have nitrate concentration values that are higher than permitted limits, ranging from 14.2 to 173.2 ppm. The permissible range for the iron concentration levels is 0.082 to 0.087 ppm. In some samples, the values for copper concentration above safe limits vary from 0.001 to 0.617 ppm. Both concentrations of the fluoride and ammonia were of acceptable levels.

Still, the bacteriology tests assured the presence of E.coli and Coliform which are harmful and found in variable levels which are of low to moderate harm according to the WHO.

6. Conclusion

The chemical and microbiological quality of well water in Al-Lith, Makkah Al-Mukarramah province has been assessed throughout the course of the observation period. During that time, 7 water samples in total were taken. In general, the risk profiles of specific samples varied, with some exhibiting high-risk characteristics and others being relatively low risk. It is determined that the bacteriological quality of the water is worrying based on the levels of total and fecal coliforms in addition to E. coli

These findings suggest that there are some problems with the analyzed water's quality. The water is contaminated, as evidenced by levels for nitrate, total water hardness, calcium and chlorine that are higher than permitted. The levels of ammonia, magnesium iron, copper, fluoride, and turbidity, however, are within permissible bounds. As a result, effective actions must be taken to raise the quality of the water. To verify that the water treatment system is properly eliminating contaminants, it is crucial to monitor and evaluate it. If necessary, extra steps may need to be taken to purify the water and lower pollutant concentrations to levels that are acceptable. It is also necessary to perform additional bacteriological testing to determine the extent of bacterial contamination and confirm that fecal bacteria are not contaminating the water.

7. Recommendation

Measures should be taken to improve water quality, especially regarding turbidity, chlorine concentration, total hardness, and nitrate concentration. The water treatment system should be monitored and reviewed to ensure its efficiency in removing high levels of contaminants. Additional measures may be necessary to purify the water and reduce the concentrations of high-level contaminants to acceptable levels. Additional bacteriological tests should be conducted to assess bacterial contamination levels and ensure the safety of water from enteric bacteria such as coliform and E. coli. Users should be educated about the importance of using safe water and purifying it before drinking and other uses. Regular tests should be conducted on well water to ensure its sustainability and prevent contamination, with immediate actions taken if acceptable limits are exceeded to ensure the safety of the water used. Consultation with water treatment experts is recommended to improve water quality and implement appropriate measures for water purification and improvement. Relevant authorities and responsible entities should monitor and evaluate water quality regularly and provide necessary guidance and support to users to ensure they have access to clean and safe water for use.

8. References

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4/22/2024