Investigation of levels of bacterial contamination in some wells located within Al Bayda city and its urban

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الملخص:

تبحث هذه الدراسة في مستويات التلوث البكتيري في مياه الآبار عبر المناطق الحضرية والريفية وتسلط الضوء على الآثار المترتبة على الصحة العامة وإدارة جودة المياه. وقد تم اختيار أربع آبار تمثل كل من البيئات الحضرية والريفية لتحليل مؤشر MPN. وكشفت النتائج عن اختلافات كبيرة في مستويات التلوث بين الآبار، حيث أظهرت الآبار الحضرية مستويات أعلى من التلوث بسبب البنية التحتية القديمة للصرف الصحي. وعلى النقيض من ذلك، أظهرت الآبار الريفية، الواقعة على مسافة من مواقع التخلص من مياه الصرف الصحي، مستويات تلوث أقل. وتؤكد النتائج على التأثير الحاسم للموقع الجغرافي على جودة المياه، مع التأكيد على الحاجة إلى تحسين البنية التحتية والإدارة البيئية في المناطق الحضرية. وتؤكد نتائج الدراسة على الأبحاث السابقة التي تشير إلى مستويات تلوث أعلى في المناطق الحضرية، ولكنها تتناقض مع النتائج التي تشير إلى ارتفاع التلوث في المناطق الريفية. ومن الضروري إجراء المزيد من البحوث للتوفيق بين هذه المنظورات واستكشاف آثار الممارسات الزراعية على جودة مياه الآبار في المناطق الريفية. وتترتب على نتائج

الدراسة آثار كبيرة على الصحة العامة والإدارة البيئية، مما يسلط الضوء على الحاجة إلى تدخلات مستهدفة لضمان مياه الشرب الآمنة لكل من المناطق الريفية والحضرية.

Abstract:

This study examines the levels of bacterial contamination in well water across rural and urban populations, highlighting the implications for public health and water quality management. Four wells, representing both urban and rural settings, were selected for analysis of MPN Index. The results revealed significant differences in contamination levels between the wells, with urban wells exhibiting higher levels of pollution due to aging sewage infrastructure. In contrast, rural wells, situated at a distance from sewage disposal sites, showed lower pollution levels. The findings underscore the critical impact of geographical location on water quality, emphasizing the need for improved infrastructure and environmental management in urban areas. The study's results corroborate previous research indicating higher pollution levels in urban areas, but contradict findings suggesting higher pollution in rural areas. Further research is necessary to reconcile these perspectives and to explore the implications of agricultural practices on well water quality in rural areas. The study's outcomes have significant implications for public health and environmental management, highlighting the need for targeted interventions to ensure safe drinking water for both rural and urban populations.

Key words: *spring water, antibiotic resistance, bacteria, pathogens*

Introduction

The examination of bacterial contamination in well water across rural and urban populations represents a vital research domain, especially concerning its implications for public health and the management of water quality. Existing literature indicates notable differences in water quality between these two environments, with numerous studies shedding light on the distinct obstacles encountered by rural areas.

In a foundational study, (Ornguga, 2014) investigates groundwater quality in rural Benue State, Nigeria, revealing that the availability of safe drinking water remains a significant issue. The findings indicate that several water quality indicators surpass the standards set by the World Health Organization, particularly during the rainy season when surface runoff exacerbates contamination levels.

In a broader context, (K Pandey et al., 2014) address the global challenges associated with water quality, particularly the presence of pathogenic bacteria in various water supplies. Their extensive review emphasizes the health risks posed by water-borne pathogens and discusses the difficulties in utilizing indicator organisms for evaluating water safety. This issue is especially pertinent for rural communities that frequently depend on untreated water sources, underscoring the need for improved water quality assessment methods in these areas.

The research conducted by (Halimy Maran et al., 2016) investigates the microbiological contamination present in groundwater, establishing a connection between the characteristics of wells and the levels of contamination observed. The authors point out that the lack of regulation in well drilling practices, coupled with insufficient monitoring, significantly increases the susceptibility of rural communities to waterborne illnesses.

In contrast, (Oliver et al., 2018) direct their attention towards urban environments, where the phenomenon of eutrophication, driven by pollution, introduces a distinct array of challenges. Their findings demonstrate that urban environmental pressures can facilitate the growth of harmful algal blooms, which complicate the processes involved in treating drinking water. The research indicates that even though urban water sources are typically subjected to treatment, they may still harbor health risks associated with cyanotoxins, thereby emphasizing the critical need for robust management of water quality in urban settings.

Teresa Frederika Murray (2019) examines the implications of private drinking water wells in Maryland, establishing a correlation between the contamination of well water and occurrences of acute gastroenteritis. Utilizing microbial source tracking techniques, the study identifies the origins of contamination, revealing that rural private wells frequently face heightened risks due to a lack of regulatory oversight and limited awareness among homeowners.

The research conducted by (Khabo-Mmekoa and Momba, 2019) presents a significant disparity in water quality between rural and urban areas, indicating that rural water sources are plagued by high levels of pathogenic bacteria, whereas urban water samples demonstrate much lower contamination levels. This finding underscores the heightened vulnerability of rural populations to waterborne diseases, thereby raising concerns about public health and safety in these communities.

In this study, four wells will be examined, with pairs of wells representing both urban and rural settings. The objective is to assess the degree of variation in pollution levels between these two types of areas, utilizing Most Probable Number (MPN) as a key indicator of pollution.

Methods and material

Area of study

Green Mountain represents a prominent mountainous region in northeastern Libya, distinguished by its extensive forest coverage and elevated terrain that predominates much of the Libyan landscape. This area is notable for its significant rainfall, which contributes to the fertility of the land, making it highly conducive to agricultural activities. Furthermore, the surrounding rural locales, particularly

Alwosaita and Algariqa, are home to numerous farms that effectively utilize the nutrient-rich soil and the advantageous climatic conditions to enhance agricultural productivity.

Collection sample

Water samples were obtained from four distinct wells: Ajjnayen, Albayda Aljadida, Algariqa, and Alwosaita. Among these, Ajjnayen and Albayda Aljadida are representative of urban water sources, while Algariqa and Alwosaita reflect agricultural areas surrounding the city. For the purpose of microbial analysis, three autoclaved sterile bottles were utilized for each water sample. The collected samples were carefully stored in plastic containers with ice packs to maintain a cool temperature during transport, ensuring they did not freeze. Subsequently, these samples were delivered to the microbiology laboratory at the University of Omar Al-Mukhtar, specifically within the Faculty of Sciences, Department of Botany, for further examination.

Examine and analysis

Enumeration of bacteria: The Most Probable Number (MPN) method is recognized as a statistical approach for estimating the concentration of microorganisms, typically involving the cultivation of several sample volumes or their dilutions, often five in total. This technique is particularly employed for quantifying coliform and fecal coliform bacteria through a series of tests. In the presumptive phase, water samples of 10 ml, 1 ml, and 0.1 ml (the latter being a 1:10 dilution) are inoculated into three sets of sterilized test tubes, each containing five tubes with inverted Durham tubes filled with 9 ml of lactose broth. These are then incubated at 37°C for a duration of 24 to 48 hours. Following this incubation, the test tubes are assessed for gas production, a byproduct of coliform bacteria metabolizing lactose, which is captured in the inverted Durham tube. The number of positive tubes exhibiting gas is recorded, and the MPN is calculated using a standard reference table.

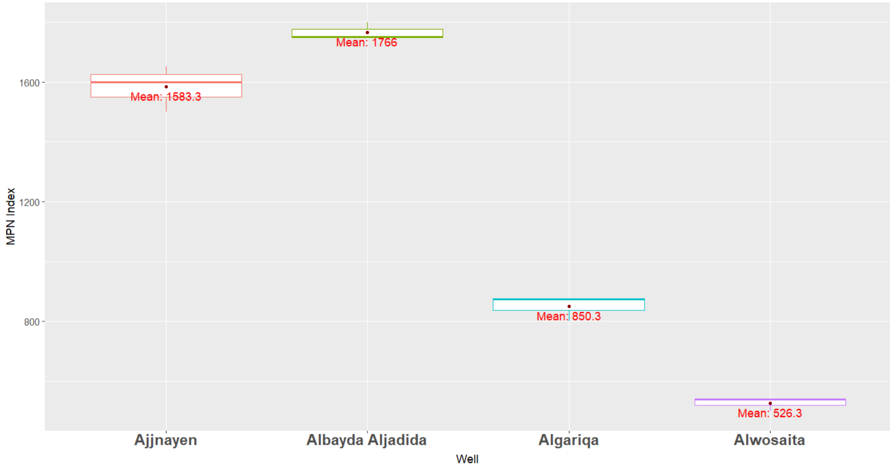
The subsequent stages of the MPN method include the confirmed and completed tests. In the confirmed test, 10 µl samples from the positive presumptive tests are streaked onto Eosin Methylene Blue (EMB) agar plates and incubated at 37°C for 24 to 48 hours. For the completed test, lactose broth is inoculated with the positive confirmed test samples and incubated at 44.5°C for 24 to 48 hours. After this incubation period, the test tubes are again evaluated for gas production, with positive results leading to further counting and MPN determination from the standard table. Additionally, 10 µl from the positive completed tests are also streaked onto EMB plates and incubated at 37°C for the same duration. To confirm the identity of the bacteria, differential staining, specifically Gram staining, is performed to verify that the bacteria are gram-negative and rod-shaped (Bumadian et al., 2013).

The data gathered during the research was carefully imported into the R software for statistical analysis. Following this, an Analysis of Variance (ANOVA) was conducted to assess the variance among the means and to determine the degree of difference in pollution levels across the four wells. Additionally, a t-test for independent samples was employed to examine the disparities in pollution levels between the agricultural areas and the urban environment.

Results:

The analysis of variance (ANOVA) revealed significant levels of contamination across the four wells, as illustrated in Figure (1). The mean concentrations of wells exhibited considerable variability among the wells ($F = 456.8$, p-value = 2.79e-09) indicating a statistically significant difference.

To further investigate the differences in pollution levels among the wells, a Tukey multiple comparisons of means test was performed. The results indicated that all wells displayed substantial differences in



contamination levels (p-values < 0.05) for each pairwise comparison, confirming the heterogeneity in pollution across the sampled sites.

Figure (1). The box plot demonstrates the differences in average pollution levels across the four wells. Notably, the Albayda Aljadida well exhibits the highest average pollution, as indicated by the MPN index, while the Alwosaita well records the lowest average pollution levels.

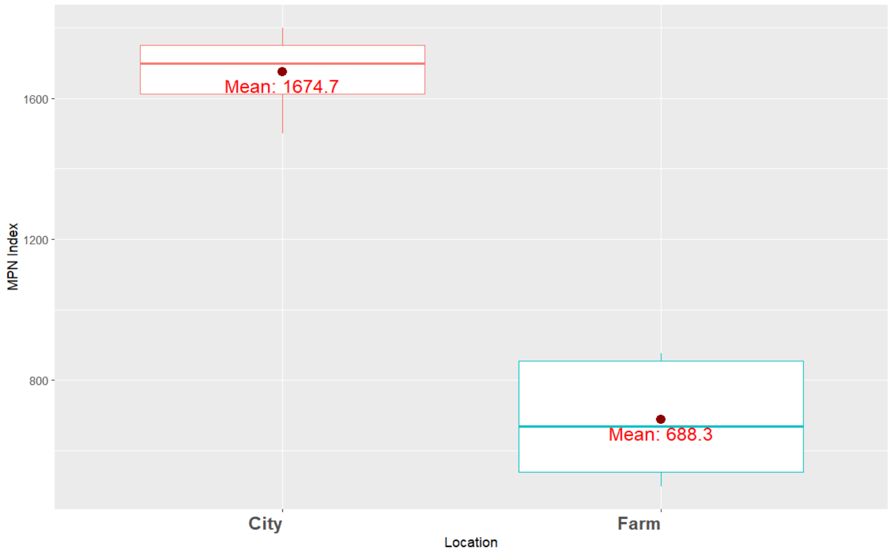
The independent samples t-test revealed a significant disparity between the water quality of wells located in agricultural areas and those situated in urban environments (t = 11.37, p-value = 2.19e-06), as depicted in figure (2). This pronounced variation can be attributed to the aging sewage infrastructure in the city, which has resulted in contamination of the water supply due to leaks. In contrast, the wells associated with productive farms are positioned at a considerable

Figure (2). The box plot illustrates the variation in average pollution levels among the city's wells as a collective group. The data reveals that the highest average pollution is found within these city's wells, whereas the lowest average pollution is associated with the wells located on farms.

distance from sewage disposal sites, rendering them less vulnerable to pollution compared to their urban counterparts.

The findings underscore the critical impact of geographical location on water quality, highlighting the stark differences between rural and urban well systems. The contamination risks faced by city wells, exacerbated by outdated sewage systems, contrast sharply with the relatively pristine conditions of farm wells, which benefit from their separation from potential sources of pollution. This analysis not only emphasizes the importance of infrastructure in maintaining water quality but also raises concerns regarding public health and environmental management in urban settings.

Discussion



This study investigates the contamination levels in water from four wells located in different geographical contexts—agricultural and urban areas. Utilizing Analysis of Variance (ANOVA), significant differences in contamination levels among the wells were identified, indicating considerable variability. An independent samples t-test further revealed a marked difference in water quality between wells in agricultural and urban environments, with urban wells suffering from contamination due to aging sewage infrastructure. In contrast, agricultural wells, distanced from sewage disposal sites, exhibited lower pollution levels. These findings highlight the significant impact of geographical location on water quality, with urban wells facing heightened contamination risks, thus raising critical concerns for public health and environmental management in urban areas.

The findings of this study largely corroborate the conclusions drawn by Oliver et al. (2018), which indicate that urban pollution levels surpass those found in rural areas. However, these results stand in stark contrast to the assertions made by M. N. Khabo-Mmekoa and N. B. Momba (2019), who reported that rural wells exhibit higher levels of pollution compared to their urban counterparts. This discrepancy highlights the complexity of pollution dynamics and suggests that further investigation is warranted to reconcile these differing perspectives.

To enhance our understanding of well water quality, it is essential to conduct additional research across various well locations and during different seasonal periods. Such studies would provide a more comprehensive view of the factors influencing water pollution in both urban and rural settings. The variability in pollution levels may be influenced by a range of environmental and anthropogenic factors that require thorough examination.

Furthermore, it is crucial to explore the implications of agricultural practices on well water quality, particularly in rural areas where farm wells are prevalent. The presence of domestic animals and the specific geographical characteristics of these regions may significantly affect water contamination levels. A focused investigation into these elements will contribute to a more nuanced understanding of the sources and extent of pollution in well water systems.

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