

Original article

Evaluation of Prevalent Drinking Water Sources in the City of Tarhuna and its Suburbs: Compliance with Local and International Standards

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Abstract

This study was conducted to assess the quality of drinking water obtained from different sources by examining selected physicochemical and microbiological parameters in accordance with the Libyan Drinking Water Standards (2015). A total of seven samples were collected from commonly used sources, including rainwater harvested from rooftops and stored in underground household tanks, as well as water supplied by various desalination stations. The evaluated parameters comprised pH, electrical conductivity (EC), total dissolved solids (TDS), and microbiological indicators, including Total Coliform and Faecal Coliform bacteria. The results demonstrated that most physicochemical properties were within the acceptable limits defined by the Libyan standards. The measured pH values ranged from 7.00 to 8.70, EC values from 49 to 310 $\mu\text{S}/\text{cm}$, and TDS concentrations from 31 to 205 mg/L, indicating generally low levels of mineral content. However, microbiological analysis revealed clear differences among the sampled sources. Rainwater stored in aged underground cement tanks exhibited significant contamination, with 22 Faecal Coliform and 184 Total Coliform counts, indicating that this water is unsuitable for consumption without treatment. In contrast, desalinated water samples exhibited either complete absence or negligible levels of microbial contamination, reflecting high treatment efficiency and safety. Overall, the findings indicate that while most samples meet chemical quality standards, microbiological contamination is primarily linked to storage conditions. This highlights the importance of proper maintenance of household tanks and regular monitoring to ensure the safety of drinking water.

Keywords. Drinking Water, Tarhuna, Compliance, Standards.

Introduction

Safe drinking water is essential for human survival and plays a fundamental role in promoting public health and sustainable development. The availability of clean water is widely recognized as a key indicator of societal well-being and environmental health, as contaminated water sources are closely associated with the spread of infectious diseases and adverse health outcomes [1]. The importance of water in sustaining life is also emphasized in religious texts, as stated in the Holy Quran: "We made from water every living thing" (Surah Al-Anbiya, 21:30). Scientifically, water is a naturally occurring compound consisting of hydrogen and oxygen, characterized by its lack of color, taste, and odor. It is indispensable for various human activities, including domestic use, agriculture, industrial production, sanitation, and energy generation [2]. Drinking water is defined as water that is safe for human consumption and free from harmful levels of physical, chemical, and biological contaminants. To achieve this, water is typically subjected to treatment processes such as filtration, disinfection, and removal of suspended materials and microorganisms [3].

Despite its abundance, water quality varies considerably depending on environmental conditions, geological features, and human activities. Factors such as rapid population growth, urbanization, agricultural practices, and industrial operations contribute significantly to water pollution and degradation [4]. Therefore, monitoring water quality has become essential for safeguarding public health and ensuring sustainable water management. In Libya, access to safe drinking water remains challenging in many regions due to arid climate conditions, limited water resources, and infrastructural constraints. Consequently, many communities rely on alternative sources such as desalinated water, groundwater, and commercially treated water [5]. Previous studies conducted in Libya have emphasized the importance of water quality evaluation. Physicochemical parameters such as pH, electrical conductivity, and total dissolved solids are widely used as indicators of water suitability for consumption [6]. Additionally, research on bottled water has shown that variations in chemical composition, including mineral content and hardness, may occur even when standards are met, highlighting the need for continuous monitoring [7]. Furthermore, studies conducted in Tripoli

confirmed that assessing both physicochemical and microbiological parameters is essential to ensure compliance with national and international standards, including those established by the World Health Organization [8].

International guidelines recommend that drinking water must be free from pathogenic microorganisms, harmful chemicals, and undesirable sensory characteristics such as taste and odor. The acceptable pH range typically lies between 6.5 and 8.5 [1]. Poor water quality poses serious health risks, as microbial contamination can lead to diseases such as cholera, typhoid, and gastrointestinal infections. In addition, chemical pollutants such as heavy metals, nitrates, and pesticides may cause long-term health effects [4]. In the city of Tarhuna and its surrounding areas, residents depend on multiple water sources due to irregular public supply. These sources include desalination stations near mosques and commercial areas, as well as rainwater collected from rooftops and stored in underground reservoirs. Given the variability in water quality among these sources, a systematic assessment is necessary to determine their suitability for consumption. Accordingly, this study aims to evaluate the quality of drinking water from different sources in Tarhuna and its suburbs by analyzing selected physicochemical and microbiological parameters. The results are expected to contribute to raising awareness and supporting effective water management strategies in the region.

Drinking water sources in Tarhuna are diverse. Most residents depend primarily on desalination plants located near commercial areas and mosques. Others rely on rainwater collected from rooftops and stored in underground tanks connected through piping systems. Traditional systems such as *Al-Mājen* are commonly used for rainwater collection, while other households utilize different types of underground storage tanks locally referred to as *Formats*. In rural and agricultural areas, some individuals collect water directly from valleys and mountainous regions. Additionally, higher-income households often purchase bottled water from desalination companies such as "Dijla" and "Al-Nabaa," which typically conduct periodic quality testing to ensure compliance with safety standards.

The objectives of the study were clearly defined to ensure a comprehensive assessment of drinking water in Tarhuna and its surrounding areas. First, the research aimed to identify and document the principal sources of drinking water available to the local population, thereby establishing a baseline understanding of supply systems. Second, the study sought to evaluate the quality of these water sources through systematic physical, chemical, and microbiological analyses, providing a multidimensional perspective on safety and suitability for consumption. Third, the results obtained from these analyses were compared against both national and international drinking water standards, allowing for an objective appraisal of compliance and highlighting any deviations from established guidelines. Finally, the investigation aimed to identify potential risks associated with the current state of water quality and to propose evidence-based recommendations for improvement, thereby contributing to public health protection and sustainable resource management in the region.

Materials and Methods

Instruments and Analytical Procedures

A range of standardized laboratory instruments and analytical techniques was employed to assess the physicochemical and microbiological characteristics of the collected drinking water samples. The evaluated parameters included electrical conductivity (EC), pH, and total dissolved solids (TDS), as well as microbiological indicators of contamination. Electrical conductivity was measured using a calibrated EC meter, while pH values were determined using a digital pH meter to assess hydrogen ion concentration. Total dissolved solids were quantified to evaluate the overall mineral content of the water samples. Microbiological quality was investigated through the detection of Total Coliform and Faecal Coliform bacteria as key indicators of water contamination. The analysis was conducted using the membrane filtration technique, a widely recognized and reliable method for microbial assessment of water. In this procedure, membrane filters with a pore size of 0.45 μm were utilized to retain bacterial cells, followed by appropriate culturing for identification and enumeration.

Water Sampling

The water samples, as outlined in (Table 1), were collected from the most frequently utilized drinking water sources within Tarhuna city and its surrounding regions. These sources were selected to provide a representative assessment of the water quality commonly consumed by the local population.

Table (1). Type of water samples

No	Sample
1	Water collected from a rooftop and stored in an Old Underground cement water reservoir.
2	Water collected from a Rooftop Connected to a Modern Underground cement water reservoir.
3	Water collected from a Rooftop Connected to a Modern Underground cement water reservoir.
4	Sample collected from the Sidi Al-Said desalination station 1.
5	Water sample from the Sidi Al-Said Desalination Station 2.
6	Water from a Desalination Station Near the Mosque in the Maji area.
7	Water from the Fum Malgha Desalination Station Near the Mosque.

The bottles from seven places, which represent the common source of drinking water in the area, were 0.5 liters in volume, carefully selected to be securely sealed and free from defects before being transported to the laboratory for analysis. In Tarhuna and its surrounding areas, the study identified two common sources of drinking water that serve as the primary supply for local communities. The first source consists of rainwater collected from residential rooftops and stored in underground tanks, a traditional practice that provides households with a relatively accessible means of water storage, though it is highly dependent on seasonal rainfall. The second source is water obtained from local desalination stations, which are typically situated near shops and mosques, offering treated water to residents in more centralized locations. Together, these sources reflect both the reliance on natural collection methods and the growing dependence on small-scale technological interventions to meet the population's drinking water needs. The samples were collected and analyzed. Three samples were collected from underground household tanks that store rainwater collected from rooftops, and four samples were collected from four different desalination stations located in areas frequently visited by residents to obtain drinking water.

Results and Discussion

The assessment of drinking water quality is a key component in evaluating public health safety, since both physicochemical characteristics and microbiological content directly determine its appropriateness for human consumption. The Libyan Standard for Drinking Water (2015) provides regulatory limits for essential parameters such as pH, electrical conductivity (EC), and total dissolved solids (TDS), in addition to microbiological indicators, including Total Coliform and Faecal Coliform bacteria. According to these criteria, Faecal Coliform organisms must not be detected in drinking water, while Total Coliform should be absent or present only at minimal levels (National Center for Standardization and Metrology, 2015).

A total of seven water samples were analyzed, and the corresponding results are summarized in (Table 2). The first sample, consisting of rooftop-harvested rainwater stored in an aged underground tank, exhibited considerable microbial contamination. The analysis identified 22 Faecal Coliform cells alongside 184 Total Coliform cells, both of which significantly exceed the acceptable limits established by Libyan standards. The occurrence of Faecal Coliform bacteria indicates contamination originating from fecal sources, potentially due to leakage from sewage systems or inadequate maintenance of storage facilities. Furthermore, insufficient sealing of tanks may allow external contaminants such as dust particles, insects, and debris to infiltrate through ventilation openings [12]. With respect to physicochemical properties, the measured pH value (7.70) remained within the acceptable interval (6.5–8.5).

Likewise, EC (202 $\mu\text{S}/\text{cm}$) and TDS (131 mg/L) values were substantially below the maximum permissible thresholds (1000 $\mu\text{S}/\text{cm}$ and 1000 mg/L). These findings indicate that the principal issue affecting this sample is microbiological rather than chemical. Similar observations have been reported in previous studies, which identified poorly maintained underground storage systems as significant contributors to microbial contamination, particularly when water is stored for prolonged durations [10]. The second sample, collected from rainwater stored in a newly constructed underground cement reservoir, demonstrated no detectable Faecal Coliform bacteria, indicating the absence of direct fecal contamination. However, 25 Total Coliform cells were recorded, indicating the presence of secondary contamination. This type of contamination is commonly associated with deficiencies in sanitation practices or contamination introduced during storage and distribution processes, including entry through pipelines or inadequately sealed reservoirs [9]. Chemically, the pH value (8.70) slightly exceeded the upper limit recommended by the Libyan standard. This increase

is likely related to the presence of dissolved carbonate and bicarbonate species resulting from water–rock interactions. Although such a slight elevation in pH does not typically present a direct health concern, it may influence the organoleptic properties of water and contribute to scaling within distribution systems [12]. The EC (238 $\mu\text{S}/\text{cm}$) and TDS (156 mg/L) values remained within acceptable ranges, indicating moderate mineral content. The third sample, also derived from rooftop rainwater stored in a modern underground tank, demonstrated complete absence of both Total Coliform and Faecal Coliform bacteria, confirming compliance with microbiological standards. The pH value (8.26) was within the permissible range, while EC (236 $\mu\text{S}/\text{cm}$) and TDS (154 mg/L) values were relatively low, indicating satisfactory chemical quality.

Table (2). values of measured parameters of samples and the Libyan drinking water standards

No	sample	Faecal Coliform	Total Coliform	PH	EC	TDS
Libyan Standards Limits		0	0	6.5 – 8.5	1000\geq	1000\geq
1	Water collected from a rooftop and stored in an Old Underground cement water reservoir.	22	184	7.70	202	131
2	water collected from a Rooftop Connected to a Modern Underground cement water reservoir.	0	25	8.70	238	156
3	water collected from a Rooftop Connected to a Modern Underground cement water reservoir.	0	0	8.26	236	154
4	sample, collected from the Sidi Al-Said desalination station, 1.	0	19	7.77	49	31
5	Water sample from the Sidi Al-Said Desalination Station 2.	0	0	7.00	61	39
6	water from a Desalination Station near the Mosque in the Maji area.	0	0	7.70	310	205
7	water from the Fum Malgha Desalination Station near the Mosque	0	0	7.00	63	41

These findings imply that the original water source is likely of acceptable quality and that variations observed in other samples may be attributed primarily to storage conditions rather than source contamination. The fourth sample, obtained from Sidi Al-Said Desalination Station (1), revealed no detectable Faecal Coliform bacteria; however, 19 Total Coliform cells were present. This indicates minor contamination occurring after the desalination process, most likely during storage or distribution. Desalination processes, particularly reverse osmosis (RO), are highly efficient in removing microbial and chemical contaminants; therefore, the detection of Total Coliform bacteria is typically linked to post-treatment contamination within the distribution network [11].

The physicochemical analysis indicated very low values (pH = 7.77, EC = 49 $\mu\text{S}/\text{cm}$, TDS = 31 mg/L), which are characteristic of desalinated water due to its low salt content. The fifth sample, collected from Sidi Al-Said Desalination Station (2), exhibited a complete absence of both Total Coliform and Faecal Coliform bacteria, indicating excellent microbiological safety. The pH value was approximately neutral (7.00), and both EC (61 $\mu\text{S}/\text{cm}$) and TDS (39 mg/L) values were low, reflecting the effectiveness of the desalination process in removing dissolved constituents. The sixth sample, obtained from a desalination facility located near the mosque in the Maji area, exhibited no evidence of microbiological contamination. However, it recorded the highest EC (310 $\mu\text{S}/\text{cm}$) and TDS (205 mg/L) values among all analyzed samples.

Despite this increase, the values remain within the acceptable limits defined by the Libyan standard. This relative elevation may be explained by the practice of blending desalinated water with small proportions of untreated or groundwater to enhance taste, a method commonly adopted in certain desalination systems [12]. The seventh sample, collected from the Fum Malgha desalination station, demonstrated the complete absence of both Total Coliform and Faecal Coliform bacteria, indicating a high level of microbiological safety. The pH value was approximately 7.00, while EC (63 $\mu\text{S}/\text{cm}$) and TDS (41 mg/L) values further confirm the high quality of the treated water.

Overall Assessment

In general, the analyzed samples complied with Libyan drinking water standards in terms of physicochemical parameters, as EC and TDS values were consistently within acceptable ranges. However, certain samples, particularly those stored in household underground reservoirs, displayed significant microbiological contamination, rendering them unsuitable for consumption. These findings emphasize that deterioration in water quality often occurs after distribution, primarily due to inadequate storage practices. Consequently, household storage systems represent a critical factor influencing the final quality of drinking water.

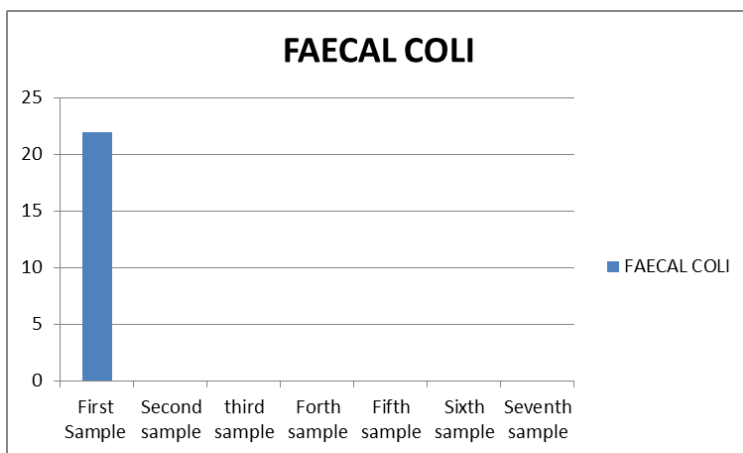


Figure 1. Faecal Coliform in each sample

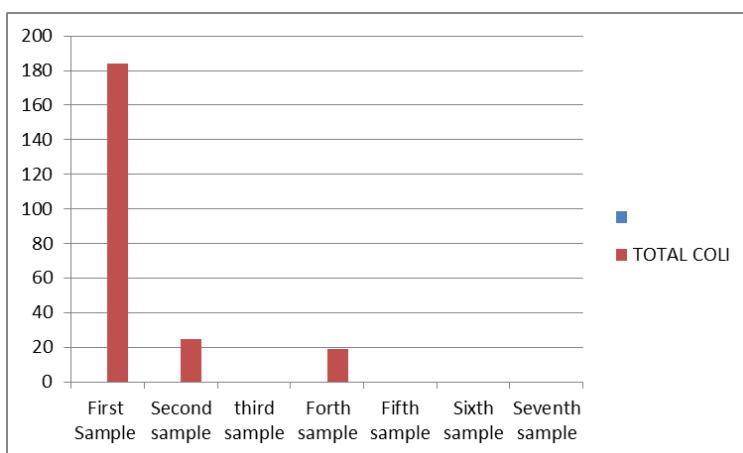


Figure 2. Total Coliform in each sample

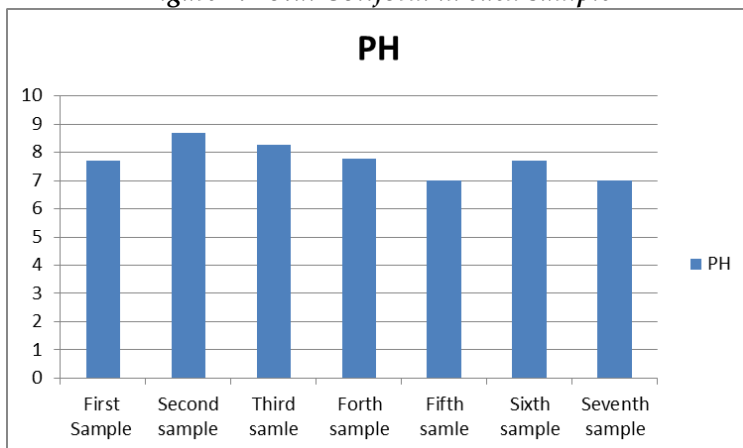


Figure 3. Value of PH in each sample

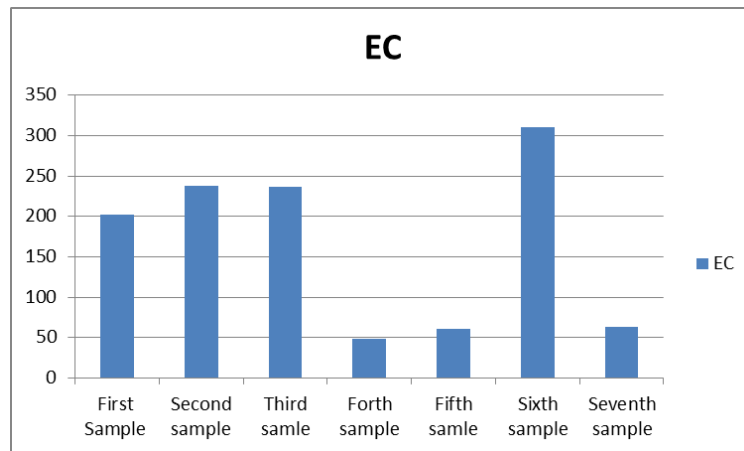


Figure 4. Value of electrical conductivity (EC) in each sample

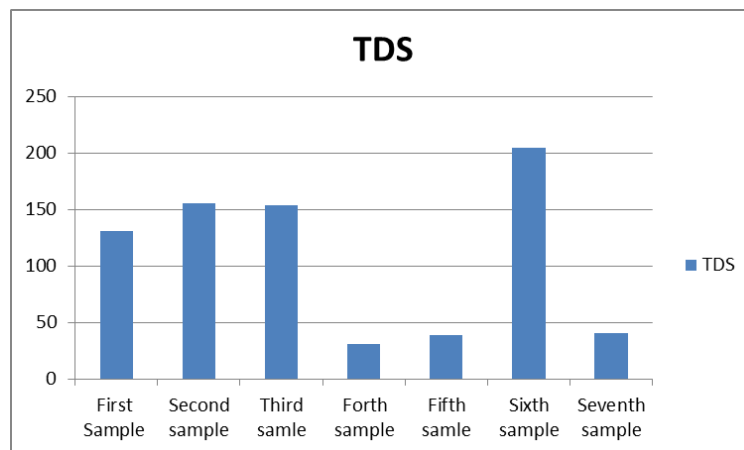


Figure 5. Value of total dissolved solids (TDS) in each sample

Recommendations

Based on the outcomes of this study, the following recommendations are proposed:

1. Periodic cleaning and disinfection of household water storage tanks.
2. Ensuring proper sealing of storage systems to prevent external contamination.
3. Implementing routine monitoring of water quality at the point of consumption

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