



Microbial Evaluation of the Fountains of Apollo and Al-Houfra and the Study of Biodiversity in Stagnant Water in the City of Cyrene

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ABSTRACT

Keywords:

E. coli, diatoms, biodiversity, stagnant water, Cyrene, Libya.

This study aimed to evaluate the microbial contamination and biological diversity of two historical fountains (Apollo and Al-Houfra) and stagnant water bodies in the ancient city of Cyrene, Libya. The microbial load, especially the presence of *Escherichia coli*, was assessed as an indicator of fecal contamination. Additionally, the biodiversity of stagnant water was investigated, revealing dominance of diatomaceous algae and other aquatic organisms such as snails and duckweed (*Lemna sp.*). The findings highlight the environmental impact of anthropogenic activities on freshwater quality and the need for monitoring natural fountains to preserve their ecological and cultural value.

Introduction

Water pollution refers to any alteration in the physical, chemical, or biological properties of water that reduces its suitability for various uses [1,2]. Surface waters—such as rivers, lakes, and fountains—are often polluted by the direct discharge of untreated effluents. Groundwater contamination also poses a serious concern, resulting from excessive use of fertilizers and pesticides and the disposal of domestic and industrial wastes in unqualified areas. This research was conducted on the Apollo and Al-Houfra fountains in Cyrene to assess microbial contamination using *Escherichia coli* as an indicator organism [3,4]. The results revealed the presence of *E. coli* and numerous bacterial colonies in both water sources. Furthermore, stagnant water from the area was analyzed to identify its biological diversity, which showed a predominance of diatomaceous algae, aquatic snails, and water lenses (*Lemna sp.*) [5]. Wastewater is known to contain suspended solids, organic pollutants, and microbial contaminants, including nutrients that lead to eutrophication. Such processes cause severe environmental degradation and health hazards [6,7]. Conventional biological methods and antibiotics are commonly used to eliminate *E. coli* and other harmful microbes from wastewater [8-10].

Materials and Methods

Experimental Section

Samples were collected from three locations:

Apollo Fountain

Al-Houfra Fountain

Stagnant water near Apollo Fountain

Each sample (6 L) was transported in sterile plastic containers and aerated using oxygen pumps (Figure 4). Bacterial cultures were grown on nutrient agar and MacConkey agar media to identify *E. coli* and other bacterial species.

At the same time, algal and invertebrate diversity was assessed microscopically. Identification of freshwater algae and organisms was performed using standard taxonomic keys [1, 12].

RESULTS

Microbial Evaluation

The microbial hazard of the Apollo and Al-Houfra fountains was confirmed through the detection of *Escherichia coli* in all five replicates for each sample (Figures 5 and 6). Additionally, lactose-positive Gram-negative bacteria were observed, indicating contamination from organic and possibly fecal sources.





Figure 1. Apollo fountain



Figure 2. stagnant water apollo



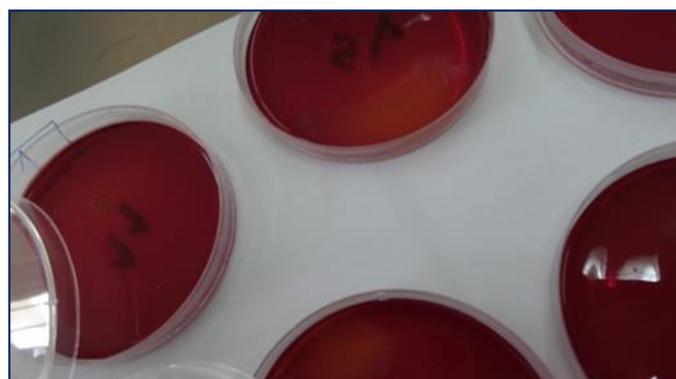
Figure 3. al-houfra fountain.



Figure 4. The three samples were supplied with oxygen by pumps



(a)



(b)

Figure 2. (a) *Escherichia E. coli* with apollo water.; (b) *Escherichia E. coli* with and al-houfra water.

Stagnant Water Biodiversity

Analysis of the stagnant water revealed the presence of diverse microorganisms, including algae (*Euglena*, *Nitzschia*), protozoa (*Paramecium*), aquatic snails, and duckweed (*Lemna sp.*) (Figures 7–12). Colony counts showed variable bacterial concentrations across samples (Table 1).

Table 1. List replicates bacterial colonies

Sample location	Number of replicates (number of bacterial colony colonies / ml)	
al-houfra water	34×10 ¹	22×10 ¹
apollo water	75×10 ⁵	38×10 ⁶
stagnant water apollo	55×10 ³	28×10 ⁵

The microbial results confirm that the fountains are exposed to external contamination sources. Meanwhile, the stagnant water supports a rich micro-ecosystem dominated by diatoms, which serve as key primary producers in freshwater environments [10].

Some of the dominant organisms have been described in three water samples including algae's (***Euglena*, *Navicula*, *Nitzschia***) and ***Paramecium*** and **Shelled water snails** and **water lens** also ***Escherichia coli*** figure (7, 13).]



Figure (7) ; *Euglena* algae



Figure (8); *Navicula* algae



Figure (9); *Nitzschia* algae



Figure (10); *Paramecium*



Figure (11); *Shelled water snails*

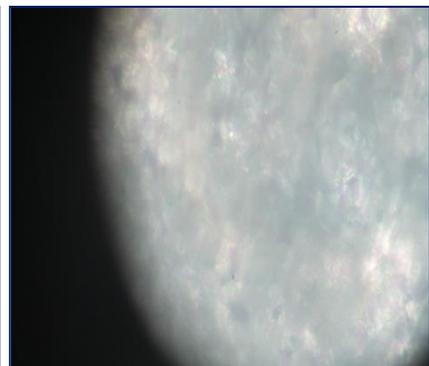
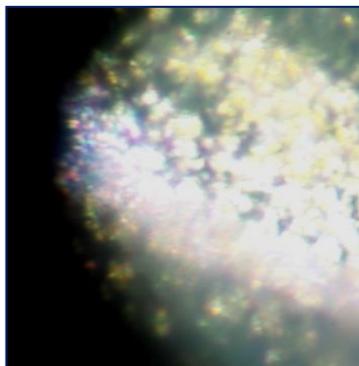


Figure (12); *Water lens* show under microscope live and dead cells

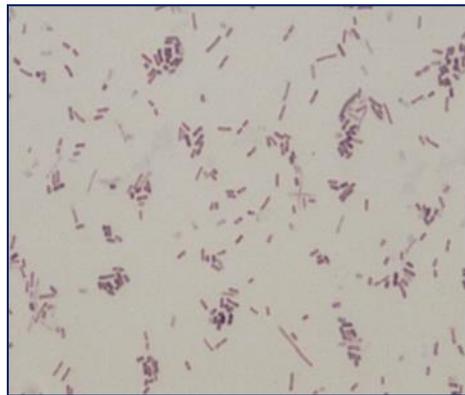


Figure (13); Escherichia coli

Environmental Implications

The detection of *E. coli* indicates anthropogenic pollution and possible sewage infiltration. Biodiversity findings suggest that although stagnant water bodies host diverse species, they are also potential reservoirs of pathogenic microbes. Effective environmental management and periodic microbiological assessment are therefore essential to maintain ecological and public health safety in Cyrene's historical fountains.

Recommendations

- **Regular Monitoring:** Continuous microbiological and chemical assessment of public water sources in Cyrene should be implemented to ensure public health safety.
- **Water Treatment:** Installation of basic filtration or chlorination systems is recommended to minimize microbial contamination.
- **Pollution Control:** Strict regulation of wastewater discharge near historical fountains and natural springs must be enforced.
- **Public Awareness:** Educate local communities about the risks associated with using untreated water for domestic or recreational purposes.
- **Further Research:** Future studies should employ molecular identification and antimicrobial resistance profiling to better understand the microbial ecology and health risks.

Conclusion

The Apollo and Al-Houfra fountains and adjacent stagnant waters are ecologically active systems affected by microbial contamination. The study confirms the presence of *E. coli* and other bacterial forms, alongside a diverse range of algal and aquatic species. Continuous monitoring and proper waste management are necessary to preserve water quality and prevent public health risks in these heritage water sources.

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ETHICS

Not applicable. No ethical issues are expected to arise from the publication of this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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