ScienceDirect

Talanta

Volume 274, 1 July 2024, 125962

Recent developments of (bio)-sensors for detection of main microbiological and non-biological pollutants in plastic bottled water samples: A critical review

Sofiene Mansouri [a] [b]

https://doi.org/10.1016/j.talanta.2024.125962

Get rights and content

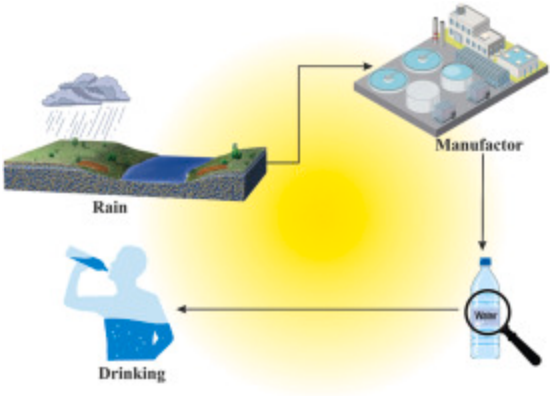
Highlights

- Recent developments of (bio)-sensors for the determination of contaminants in bottled drinking water.
- Detection of microbiological and non-biological contamination of bottled drinking water.
- The role of nanomaterials, bioreceptors and techniques in the development of (bio)-sensors.

Abstract

The importance of water in all biological processes is undeniable. Ensuring access to clean and safe drinking water is crucial for maintaining sustainable water resources. To elaborate, the consumption of water of inadequate quality can have a repercussion on human health. Furthermore, according to the instability of tap water quality, the consumption rate of bottled water is increasing every day at the global level. Although most people believe bottled water is safe, it can also be contaminated by microbiological or chemical pollution, which can increase the risk of disease. Over the last decades, several conventional analytical tools applied to analyze the contamination of bottled water. On the other hand, some limitations restrict their application in this field. Therefore, biosensors, as emerging analytical method, attract tremendous attention for detection both microbial and chemical contamination of bottled water. Biosensors enjoy several facilities including selectivity, affordability, and sensitivity. In this review, the developed biosensors for analyzing contamination of bottled water were highlighted, as along with working strategies, pros and cons of studies. Challenges and prospects were also examined.

Graphical abstract



Download: Download high-res image (216KB)

Download: Download full-size image

Introduction

Nowadays, it is a well-known fact that food packaging has attracted considerable attention and bottled water is not an exception to this fact [1]. Up to now, water resources have been directly and indirectly associated with human health [2]. Indeed, with the continuous growth of human populations and economies, the global demand for freshwater and safe water has been rapidly increased [3,4]. In addition, lifestyle and climate change further exacerbate the strain on our vital water resources, resulting in widespread water stress

across many countries. Recently, the revolution in the food industrial has played a critical role in producing bottled water which is more accessible and safer than other water resources [5]. For example, in 2017, the value of the bottled water market was estimated at approximately $US198.50 billion which demonstrates the importance of this market [6,7]. This market contains four main categories including carbonated water, still water, flavored water, and functional water [8,9]. Over the past few decades, the worldwide bottled water industry has experienced impressive and consistent annual expansion [10]. As a substitute for conventional soft drinks, bottled water has become a popular choice for consumers seeking health and well-being [11]. On the other hand, in some cases, these types of waters pose threats to both the human food supply and biodiversity in aquatic and terrestrial ecosystems. Particularly, safe drinking water standards are strictly enforced in countries worldwide to minimize the risk of acute and chronic health hazards for consumers [12,13].

Section snippets

Microbiological and non-biological pollutants in bottled drinking water

A variety of microbial and chemical contaminations can be considered threatening agents of bottled water [14]. The presence of chemicals and substances in bottled drinking water that originate from non-living sources is known as non-biological contamination which has the potential to pose a risk to human health if their concentrations exceed established regulatory limits [15,16]. There are numerous non-biological contaminations presented in drinking bottled water and some examples are…

(Bio)-sensors evolution for bottled drinking water analysis

Due to the importance of presenting high potential technologies for constantly monitoring and recognizing microbiological and non-biological contaminations of drinking bottled water, over the past few decades, numerous techniques have been conducted to detect pollutant detection [36]. However, most of them are not economical, and alongside that, they are time-consuming [37]. Plate counting, for instance, is standard for counting the coliforms approach in the samples of water which requires…

Microbiological pollutants detection

According to the high cost and complexity analysis method of isolated pathogen microorganisms from bottled water, additionally, inconstant presence of them in water can

be considered two important matters for determination of some microbiological indicator species [47]. In other words, the presence of these species reveals implicitly the risk of contamination with pathogenic microorganisms and fecal pollution. Generally, the following indicator parameters are exploited to measure the degree of…

Non-biological pollutants detection

Non-biological contaminations contain physical and chemical hazards that may be presented naturally or through human activities such as mining, industry, wastewater, and agriculture activities. Although trace amounts of these contaminations are typical, according to the guideline of international health organizations, they can pose a threat to our lives depending on the consumption rates, type of contaminant, and concentration [85]. Recently, the exploitation of NMs and bioreceptors in the…

Conclusion and future perspective

Contamination by microbiological and non-biological pollutants is a global concern affecting bottled drinking water quality. Microbiological and chemical analysis of bottled drinking water samples is time-consuming and requires qualified individuals. Over the last decades, the introduction of novel NMs and sensing approaches that operate according to affordable and simple instruments can provide more efficient water analysis devices. Therefore, in the present work, a literature review of…

CRediT authorship contribution statement

Sofiene Mansouri: Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Funding acquisition, Conceptualization.…

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.…

Acknowledgement

This study is supported via funding from Prince sattam bin Abdulaziz University project number (PSAU/2024/R/1445).…

Recommended articles

References (137)

G. Gao *et al.*
An intelligent IoT-based control and traceability system to forecast and maintain water quality in freshwater fish farms
Comput. Electron. Agric. (2019)

M. Petronijević *et al.*
Characterization and application of biochar-immobilized crude horseradish peroxidase for removal of phenol from water
Colloids Surf. B Biointerfaces (2021)

M. Tanaka *et al.*
Role of interfacial water in determining the interactions of proteins and cells with hydrated materials
Colloids Surf. B Biointerfaces (2021)

G. Subbiahdoss *et al.*
Biofilm formation at oil-water interfaces is not a simple function of bacterial hydrophobicity
Colloids Surf. B Biointerfaces (2020)

R. Akhbarizadeh *et al.*
Worldwide bottled water occurrence of emerging contaminants: a review of the recent scientific literature
J. Hazard Mater. (2020)

M. Salehi
Global water shortage and potable water safety; Today's concern and tomorrow's crisis
Environ. Int. (2022)

A. Thakali *et al.*
A review of chemical and microbial contamination in food: what are the threats to a circular food system?

Environ. Res. (2021)

C. Zamora-Ledezma *et al.*
Heavy metal water pollution: a fresh look about hazards, novel and conventional remediation methods
Environ. Technol. Innovat. (2021)

I.C. Yadav *et al.*
Current status of persistent organic pesticides residues in air, water, and soil, and their possible effect on neighboring countries: a comprehensive review of India
Sci. Total Environ. (2015)

D. Schymanski *et al.*
Analysis of microplastics in water by micro-Raman spectroscopy: release of plastic particles from different packaging into mineral water
Water Res. (2018)

D. Lalwani *et al.*
Nationwide distribution and potential risk of bisphenol analogues in Indian waters
Ecotoxicol. Environ. Saf. (2020)

X. Liang *et al.*
Broadening the lens on bisphenols in coastal waters: occurrence, partitioning, and input fluxes of multiple novel bisphenol S derivatives along with BPA and BPA analogues in the Pearl River Delta, China
Environ. Pollut. (2023)

J.M. Park *et al.*
A remarkable adsorbent for removal of bisphenol S from water: aminated metal-organic framework, MIL-101-NH2
Chem. Eng. J. (2020)

E. Sokolova *et al.*
Data-driven models for predicting microbial water quality in the drinking water source using E. coli monitoring and hydrometeorological data
Sci. Total Environ. (2022)

B. Carrasquer *et al.*

A new indicator to estimate the efficiency of water and energy use in agro-industries

J. Clean. Prod. (2017)

R. Chandrajith *et al.*

Application of Water Quality Index as a vulnerability indicator to determine seawater intrusion in unconsolidated sedimentary aquifers in a tropical coastal region of Sri Lanka

Groundwater for Sustainable Development (2022)

Q. Liu *et al.*

Evaluation of the metabolic response of Escherichia coli to electrolysed water by 1H NMR spectroscopy

LWT--Food Sci. Technol. (2017)

N.A. Khan *et al.*

Occurrence, sources and conventional treatment techniques for various antibiotics present in hospital wastewaters: a critical review

TrAC, Trends Anal. Chem. (2020)

P. Arora *et al.*

An experimental setup and segmentation method for CFU counting on agar plate for the assessment of drinking water

J. Microbiol. Methods (2023)

H. Wang *et al.*

Deep eutectic solvent-based ultrasound-assisted dispersive liquid-liquid microextraction coupled with high-performance liquid chromatography for the determination of ultraviolet filters in water samples

J. Chromatogr. A (2017)

H.K. Kordasht *et al.*

Aptamer based recognition of cancer cells: recent progress and challenges in bioanalysis

Talanta (2020)

H. Kholafazad-Kordasht *et al.*

Smartphone based immunosensors as next generation of healthcare tools: technical and analytical overview towards improvement of personalized medicine

TrAC, Trends Anal. Chem. (2021)

W. Hu *et al.*
Bacteria in atmospheric waters: detection, characteristics and implications
Atmos. Environ. (2018)

Y. Chen *et al.*
Point-of-care and visual detection of P. aeruginosa and its toxin genes by multiple LAMP and lateral flow nucleic acid biosensor
Biosens. Bioelectron. (2016)

I. Bilican *et al.*
Alternative screening method for analyzing the water samples through an electrical microfluidics chip with classical microbiological assay comparison of P. aeruginosa
Talanta (2020)

F.A.a. Alatraktchi
Rapid measurement of the waterborne pathogen Pseudomonas aeruginosa in different spiked water sources using electrochemical sensing: towards on-site applications
Measurement (2022)

Z. Zhou *et al.*
Ultrasensitive magnetic DNAzyme-copper nanoclusters fluorescent biosensor with triple amplification for the visual detection of E. coli O157: H7
Biosens. Bioelectron. (2020)

M. Du *et al.*
Direct, ultrafast, and sensitive detection of environmental pathogenic microorganisms based on a graphene biosensor
Anal. Chim. Acta (2023)

J. Huang *et al.*
Colorimetric and photographic detection of bacteria in drinking water by using 4-mercaptophenylboronic acid functionalized AuNPs
Food Control (2020)

R. Liu *et al.*

Development of a fluorescence sensing platform for specific and sensitive detection of pathogenic bacteria in food samples
Food Control (2022)

J. Maldonado *et al.*
Label-free bimodal waveguide immunosensor for rapid diagnosis of bacterial infections in cirrhotic patients
Biosens. Bioelectron. (2016)

N. Zaraee *et al.*
Highly sensitive and label-free digital detection of whole cell E. coli with Interferometric Reflectance Imaging
Biosens. Bioelectron. (2020)

L. Wang *et al.*
Designed graphene-peptide nanocomposites for biosensor applications: a review
Anal. Chim. Acta (2017)

Z. Luo *et al.*
An aptamer based method for small molecules detection through monitoring salt-induced AuNPs aggregation and surface plasmon resonance (SPR) detection
Sensor. Actuator. B Chem. (2016)

S. Gupta *et al.*
Development of FRET biosensor based on aptamer/functionalized graphene for ultrasensitive detection of bisphenol A and discrimination from analogs
Nano-Structures & Nano-Objects (2017)

C. Liang *et al.*
Aptamer-functionalised metal-organic frameworks as an ‘on–off–on’fluorescent sensor for bisphenol S detection
Talanta (2023)

S. Şahin *et al.*
Spectroscopic ellipsometry-based aptasensor platform for bisphenol a detection
Talanta (2023)

X. Wang *et al.*
3D metal-organic framework as highly efficient biosensing platform for ultrasensitive and rapid detection of bisphenol A

Biosens. Bioelectron. (2015)

L. Wu *et al.*
Graphdiyne: a new promising member of 2D all-carbon nanomaterial as robust electrochemical enzyme biosensor platform
Carbon (2020)

P. Deng *et al.*
Electrochemical determination of bisphenol A in plastic bottled drinking water and canned beverages using a molecularly imprinted chitosan–graphene composite film modified electrode
Food Chem. (2014)

M.G. Metwally *et al.*
Electrochemical detection of Bisphenol A in plastic bottled drinking waters and soft drinks based on molecularly imprinted polymer
J. Environ. Chem. Eng. (2022)

C. Tortolini *et al.*
DNA-based biosensors for Hg2+ determination by polythymine–methylene blue modified electrodes
Biosens. Bioelectron. (2015)

R. Wang *et al.*
T–T mismatch-driven biosensor using triple functional DNA-protein conjugates for facile detection of Hg2+
Biosens. Bioelectron. (2016)

Y. Zhou *et al.*
Simple, rapid, and sensitive on-site detection of Hg2+ in water samples through combining portable evanescent wave optofluidic biosensor and fluorescence resonance energy transfer principle
Anal. Chim. Acta (2021)

J.W. Han *et al.*
Food packaging: a comprehensive review and future trends
Compr. Rev. Food Sci. Food Saf. (2018)

M. Sit *et al.*

A comprehensive review of deep learning applications in hydrology and water resources
Water Sci. Technol. (2020)

S.S. Kaushal *et al.*
Freshwater salinization syndrome: from emerging global problem to managing risks
Biogeochemistry (2021)

M.A. Xenopoulos *et al.*
How humans alter dissolved organic matter composition in freshwater: relevance for the Earth's biogeochemistry
Biogeochemistry (2021)

P.W. Ballantine *et al.*
Why buy free? exploring perceptions of bottled water consumption and its environmental consequences
Sustainability (2019)

M. Guo *et al.*
Determinants of intention to purchase bottled water based on business online strategy in China: the role of perceived risk in the theory of planned behavior
Int. J. Environ. Res. Publ. Health (2021)
There are more references available in the full text version of this article.

Cited by (1)

Synthesis of Nanocomposite Based Polysaccharide and Performance Evaluation for the Removal of Various Drug from Pharmaceuticals Wastewater ↗
2024, ChemistrySelect

View full text