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**Nataliia Tkachuk, Liubov Zelena, Ivan Shkardybarda,
Dmytro Nikolaienko, Nataliia Demchenko**

SANITARY-HYGIENIC, CLINICAL-IMMUNOLOGICAL AND ENVIRONMENTAL RISKS OF WET WIPES IN PUBLIC HEALTH CONTEXT

**Наталія Ткачук, Любов Зелена, Іван Шкардибарда,
Дмитро Ніколаєнко, Наталія Демченко**

САНІТАРНО-ГІГІЄНІЧНІ, КЛІНІКО-ІМУНОЛОГІЧНІ ТА ЕКОЛОГІЧНІ РИЗИКИ ВОЛОГИХ СЕРВЕТОК У КОНТЕКСТІ ГРОМАДСЬКОГО ЗДОРОВ'Я

ABSTRACT

The aim of the study was to review the literature on the biomedical and environmental risks associated with the use of wet wipes in the context of public health.

Methodology. This study included a bibliometric study to examine the global dynamics of research on wet wipes. Relevant publications were retrieved from two major bibliographic databases: Scopus and the Science Citation Index Expanded (SCI-Expanded) in the Web of Science (WoS). The study of bibliometric relationships was conducted using VOSviewer (version 1.6.20). Along with the bibliometric analysis, a review of a wide range of publicly available online sources covering relevant issues was conducted.

Scientific novelty. It is shown that the quality of wet wipes and their consumption by the population can determine such indicators of population health as environmental, medical and sanitary, social and behavioral. The article systematically presents information on various aspects of the issue of biomedical and environmental risks of both new and used wet wipes, including their sanitary-hygienic, clinical-immunological and environmental characteristics, as well as social aspects in the context of public health. The primary focus is on pathogenic indicator microorganisms as potential threats to human health, as well as the environmental issues arising from pollution caused by this hygiene product.

Conclusions. Based on a bibliometric review of the literature and available studies, the human health and environmental risks linked to wet wipe use were thoroughly analyzed. In general, the quality of wet wipes and their consumption by the population can determine such public health indicators as environmental, medical and sanitary, social and behavioural. Microbiological and environmental parameters that determine the safety of wet wipes for public health have become the subject of comprehensive scientific analysis. The study emphasizes pathogenic indicator microorganisms as potential health hazards and considers the environmental impact of pollution caused by this hygiene product. However, socio-pedagogical approaches aimed at forming a responsible attitude towards the use and proper disposal of wet wipes remain underdeveloped and not systematic. Future research should focus on:

- further exploring the microbial diversity of hygiene products, considering both harmful microorganisms and potential biodegraders;
- search for eco- and bio-safe materials and solutions for wetting wet wipes;
- shaping the behaviour of responsible use and consumption of wet wipes.

Key words: environmental risks, microbiological characteristics, clinical-immunological risks, sanitary-hygienic risks, public health, social aspects, wet wipes

АНОТАЦІЯ

Метою дослідження було проаналізувати літературу щодо біомедичних та екологічних ризиків, пов'язаних з використанням вологих серветок у контексті громадського здоров'я.

Методологія. Це дослідження включало бібліометричне дослідження для вивчення глобальної динаміки досліджень вологих серветок. Відповідні публікації були отримані з двох основних бібліографічних баз даних: Scopus та Science Citation Index Expanded (SCI-Expanded) у Web of Science (WoS). Дослідження бібліометричних зв'язків було проведено за допомогою VOSviewer (версія 1.6.20). Поряд з бібліометричним аналізом було проведено огляд широкого кола загальнодоступних онлайн-джерел, що охоплюють відповідні питання.

Наукова новизна. Показано, що якість вологих серветок та їх споживання населенням можуть визначати такі показники здоров'я населення, як екологічні, медико-санітарні, соціальні та поведінкові. У статті систематично викладено інформацію з різних аспектів питання біомедичних та екологічних ризиків як нових, так і вживаних вологих серветок, включаючи їх санітарно-гігієнічні, клініко-імунологічні та екологічні характеристики, а також соціальні аспекти в контексті охорони здоров'я населення. Основна увага приділяється патогенним індикаторним мікроорганізмам як потенційним загрозам для здоров'я людини, а також екологічним проблемам, що виникають внаслідок забруднення, спричиненого цим гігієнічним засобом.

Висновки. На основі бібліометричного огляду літератури та доступних досліджень було ретельно проаналізовано ризики для здоров'я людини та навколишнього середовища, пов'язані з використанням вологих серветок. Загалом, якість вологих серветок та їх споживання населенням можуть визначати такі показники громадського здоров'я, як екологічні, медико-санітарні, соціальні та поведінкові. Мікробіологічні та екологічні параметри, що визначають безпеку вологих серветок для громадського здоров'я, стали предметом комплексного наукового аналізу. У дослідженні наголошується на патогенних індикаторних мікроорганізмах як потенційній небезпеці для здоров'я та розглядається вплив забруднення навколишнього середовища, спричиненого цим гігієнічним засобом. Однак соціально-педагогічні підходи, спрямовані на формування відповідального ставлення до використання та належної утилізації вологих серветок, залишаються недостатньо розробленими та несистематизованими. Подальші дослідження мають бути зосереджені на:

- подальшому вивченні мікробного різноманіття гігієнічних засобів, враховуючи як шкідливі мікроорганізми, так і потенційні біодеградатори;
- пошуку екологічно- та біобезпечних матеріалів і рішень для змочування вологих серветок;
- формуванні поведінки відповідального використання та споживання вологих серветок.

Ключові слова: екологічні ризики, мікробіологічні характеристики, клініко-імунологічні ризики, санітарно-гігієнічні ризики, громадське здоров'я, соціальні аспекти, вологі серветки

Introduction

Modern global challenges in the field of health care and sustainable development require a comprehensive approach, which is reflected in an important approach to ensuring public health - the concept of "One World - One Health" (WHO, 2022). The basis of this concept is the close interrelationship, interdependence, and mutual influence of human, animal, and environmental health (WHO, 2022). From this perspective, the biological and ecological safety of daily hygiene products is important for preserving human health and the environment (Khalid & Abdollahi, 2021; Lin, 2023).

In the last decade, people have increasingly used wet wipes for medical purposes and in everyday life (Ramya & Amutha, 2021). Cotton and viscose are used to produce wet wipes, as well as plastics such as polyester, polyethylene, and polypropylene (Environmental and economic costs…, n.d.). More expensive wet wipes are made from spunlace and airland, and cheaper wet wipes are made from spunbond, himbond, and thermobond (Kyrychenko et al., 2020). Nonwoven wet wipes (bleached cellulose, unbleached cellulose, and low-yield soluble cellulose) were shown to have increased resistance to disintegration, but their tensile strength and disintegration energy remained unchanged (Harter et al., 2022). Sülar and Keçeci (2021) reported that the degradation of wet wipes decreased in cases with increasing polyethylene terephthalate content, and conversely, with an increase in cellulose fiber content, the level of degradation increased.

In general, the problem of environmental pollution by hygiene products, in particular, wet wipes, is acute (Environmental and economic costs…, n.d.; Bondaroff & Cooke, 2020; Allison et al., 2023), notably because they serve as a source of microplastics in the environment (Ó Briain et al., 2020). Solving this problem should be considered using a biotechnological approach – bioremediation using destructor microorganisms as an environmentally friendly method (Lumio et al., 2021; Cao et al., 2022). The growth and development of microorganisms on the surfaces of materials found in the natural environment (soil, water) occurs in the form of a biofilm, and its microbial diversity affects the processes of biodegradation of these materials (Khalid & Elsherif, 2022; Khan et al., 2023). In addition, the issue of antimicrobial properties of wet wipes is important, which should be considered from the angle of antibiotic resistance of microorganisms, since such a group can either be removed when using effective agents (Song et al., 2019; Angulo-Pineda et al., 2025), or spread when using ineffective agents (Cardiff University, 2008; Cheng et al., 2011). Consequently, this study aimed to review the literature on the biomedical and environmental risks associated with the use of wet wipes in the context of public health.

The article is a literature review containing a systematic summary of information on various aspects of the issue of bio- and ecosafety of both new and used wet wipes, including their antibacterial properties, microbiological and environmental characteristics, as well as social aspects in the context of public health.

Materials and methods

This study included a bibliometric study to examine the global dynamics of research on wet wipes. Relevant literature was collected from two leading bibliographic databases, Scopus and the Science Citation Index Expanded (SCI-Expanded) within Web of Science (WoS). Searches covered publications from 1970 to 2025. The search query included the keywords «wet wipes», which ensured comprehensive coverage of research in this area. The bibliometric analysis of relationships was performed using VOSviewer (version 1.6.20) (VOSviewer, n.d.). The following bibliometric indicators were analysed in the final list of publications: types of documents; keywords in the documents; top cited articles; authorship analysis; top productive countries; international collaboration; top productive institutions/organizations; and preferred journals for publications. Along with the bibliometric analysis, a review of a wide range of publicly available online sources covering the relevant issues was conducted. The study used a number of methods, including general scientific (theoretical analysis of available information), analytical and generalizing (for processing literary sources on the researched issues), empirical (for collecting factual data), and argumentative (for substantiating the proposed positions).

Results and Discussion

A bibliometric review

Among the types of publications on wet wipes, articles prevailed (83.6 %) (Fig. 1). A significantly lower proportion of documents were Proceeding Papers (8.4 %), Editorial Materials, and Review Articles (3.1 % each). Other types of publications ranged from 0.6 % (Early Access) and 0.4 % (Letter) to 0.2 % (Correction, Meeting Abstract, News Item, Poetry) (Fig. 1).

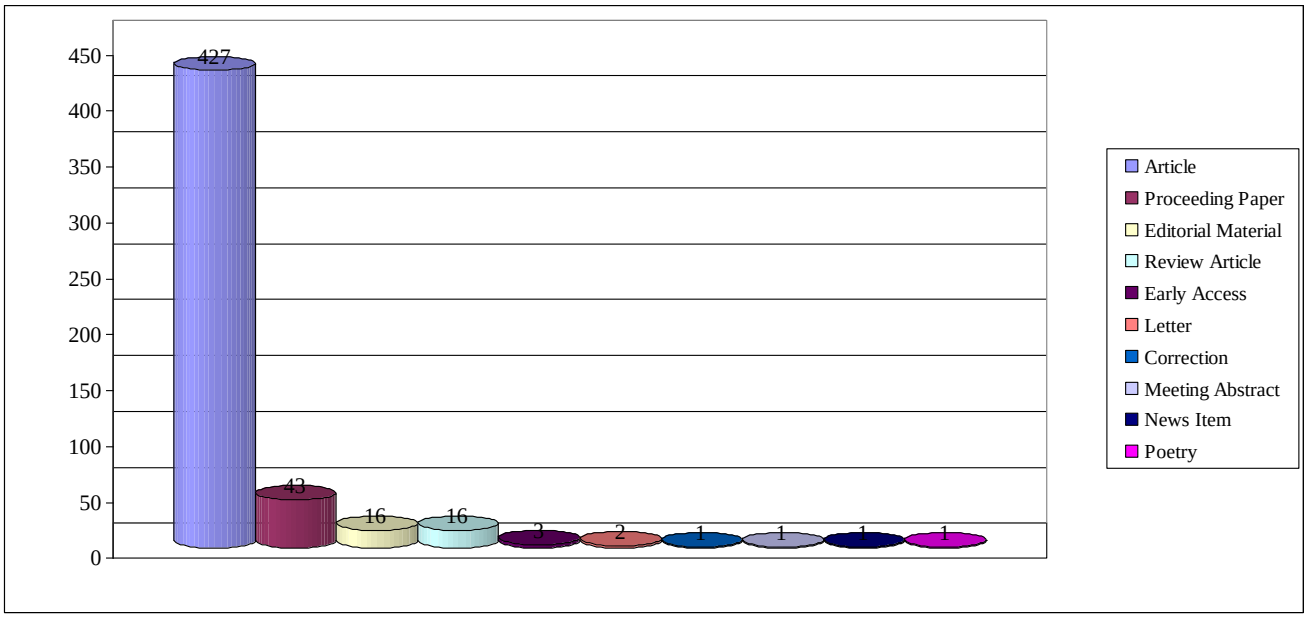

Fig. 1. Types of publications regarding wet wipes

During the years 1978-1985, only 3 publications on wet wipes were published (Fig. 2). From 1987 to 1994, the number of publications increased slightly, and from 1996 it increased to 4-6 publications per year. From 2006 onwards, there has been a notable increase in publications, with the highest count observed in 2021 at 42 (Fig. 2).

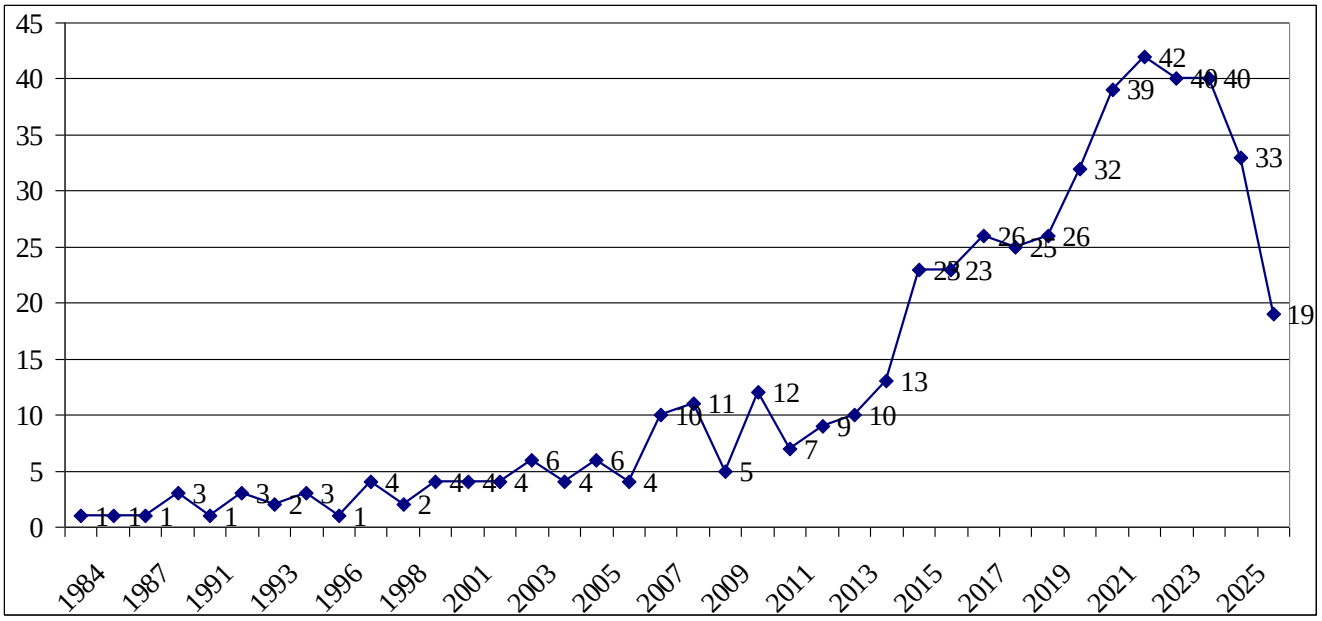

Fig. 2. Annual number of publications on wet wipes

Classification of the published articles by research area reveals the predominance of the following categories: Medical & Health Sciences (191 articles), Environmental & Earth Sciences (176 articles), Chemistry & Materials Sciences (166 articles) (Fig. 3).

In addition, the distribution of articles by these and other categories is presented in Table 1.

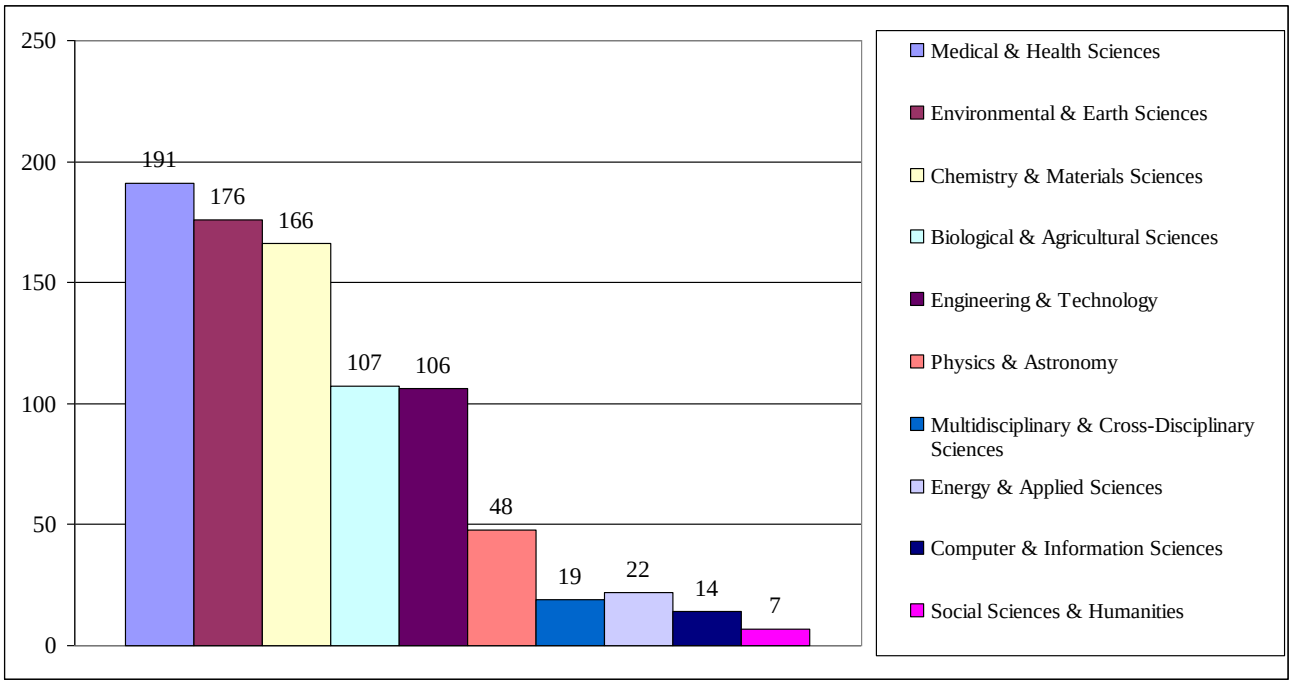

Fig. 3. Representation of key research areas in studies on wet wipes

Table 1

Distribution of retrieved publications by category and subcategory

Categories	Subcategories	Number of publications
1	2	3
Environmental & Earth Sciences	Environmental Sciences	93
	Environmental Studies	2
	Public Environmental Occupational Health	54
	Green Sustainable Science Technology	5
	Water Resources	11
	Meteorology Atmospheric Sciences	3
	Geosciences Multidisciplinary	3
	Biodiversity Conservation	3
	Ecology	1
	Geography Physical	1
	Total	*176*
Chemistry & Materials Sciences	Chemistry Analytical	19
	Chemistry Applied	9
	Chemistry Multidisciplinary	19
	Chemistry Medicinal	1
	Chemistry Physical	18
	Materials Science Multidisciplinary	33
	Materials Science Textiles	19
	Materials Science Coatings Films	6
	Materials Science Composites	2
	Materials Science Ceramics	1
	Polymer Science	20
	Spectroscopy	6
	Electrochemistry	2
	Nanoscience Nanotechnology	11
	Total	166
Biological & Agricultural Sciences	Biology	4
	Biochemistry Molecular Biology	7
	Microbiology	20
	Biotechnology Applied Microbiology	19
	Genetics Heredity	1
	Plant Sciences	3
	Agriculture Dairy Animal Science	5
	Agronomy	5
	Agriculture Multidisciplinary	3
	Veterinary Sciences	7
	Forestry	5
	Zoology	2
	Entomology	2
	Food Science Technology	20
	Marine Freshwater Biology	4
	Total	*107*

Continuation of Table 1

1	2	3
Medical & Health Sciences	Medicine General Internal	6
	Infectious Diseases	20
	Tropical Medicine	2
	Dermatology	55
	Pediatrics	17
	Surgery	2
	Obstetrics Gynaecology	2
	Radiology Nuclear Medicine Medical Imaging	4
	Dentistry Oral Surgery Medicine	2
	Nursing	6
	Health Care Sciences Services	2
	Health Policy Services	1
	Immunology	6
	Virology	2
	Allergy	21
	Toxicology	16
	Pharmacology Pharmacy	11
	Medicine Legal	6
	Gastroenterology Hepatology	2
	Ophthalmology	8
	Total	*191*
Engineering & Technology	Engineering Environmental	31
	Engineering Chemical	22
	Engineering Electrical Electronic	9
	Engineering Mechanical	9
	Engineering Multidisciplinary	8
	Engineering Civil	4
	Engineering Biomedical	6
	Engineering Aerospace	5
	Engineering Manufacturing	6
	Engineering Geological	1
	Engineering Industrial	1
	Construction Building Technology	4
	Total	*106*
Physics & Astronomy	Physics Applied Physics	19
	Condensed Matter	10
	Physics Atomic Molecular Chemical	3
	Physics Fluids Plasmas	2
	Optics	3
	Astronomy Astrophysics	4
	Nuclear Science Technology	5
	Mechanics	2
	Total	*48*
Computer & Information Sciences	Computer Science Artificial Intelligence	2
	Computer Science Information Systems	2
	Computer Science Software Engineering	2
	Computer Science Theory Methods	2
	Computer Science Interdisciplinary Applications	1
	Information Science Library Science	1
	Instruments Instrumentation	4
	Total	*14*

Continuation of Table 1

1	2	3
Social Sciences & Humanities	Education Scientific Disciplines	1
	History Philosophy of Science	1
	Literary Reviews	1
	Asian Studies	1
	Agricultural Economics Policy	1
	Ergonomics	1
	Architecture	1
	Total	*7*
Multidisciplinary & Cross-Disciplinary Sciences	Multidisciplinary Sciences	10
	Cell Tissue Engineering	3
	Biochemical Research Methods	5
	Imaging Science Photographic Technology	1
	Total	*19*
Energy & Applied Sciences	Energy Fuels	6
	Metallurgy Metallurgical Engineering	6
	Materials Science Paper Wood	10
	Total	*22*

Authors from the USA and China have the largest number of publications (Fig. 4).

Medical, environmental, and technical journals are the most prominent among those publishing articles on wet wipes. (Fig. 5).

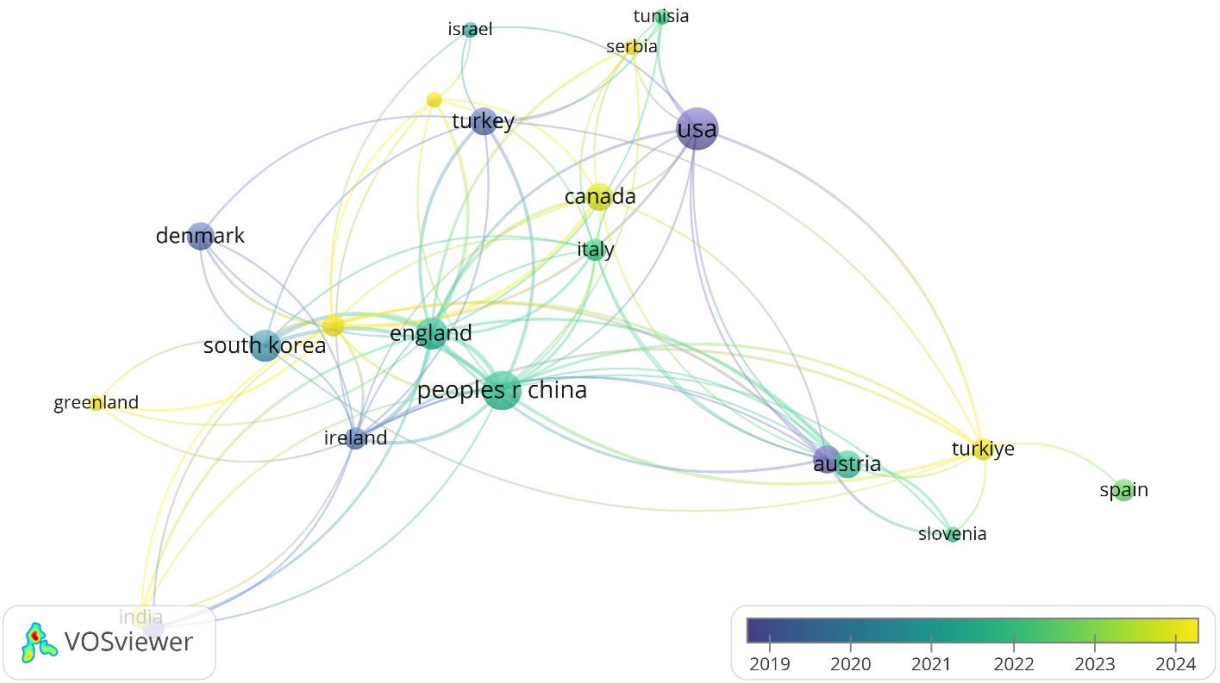

Fig. 4. Grouping of countries based on authorship of wet wipes publications

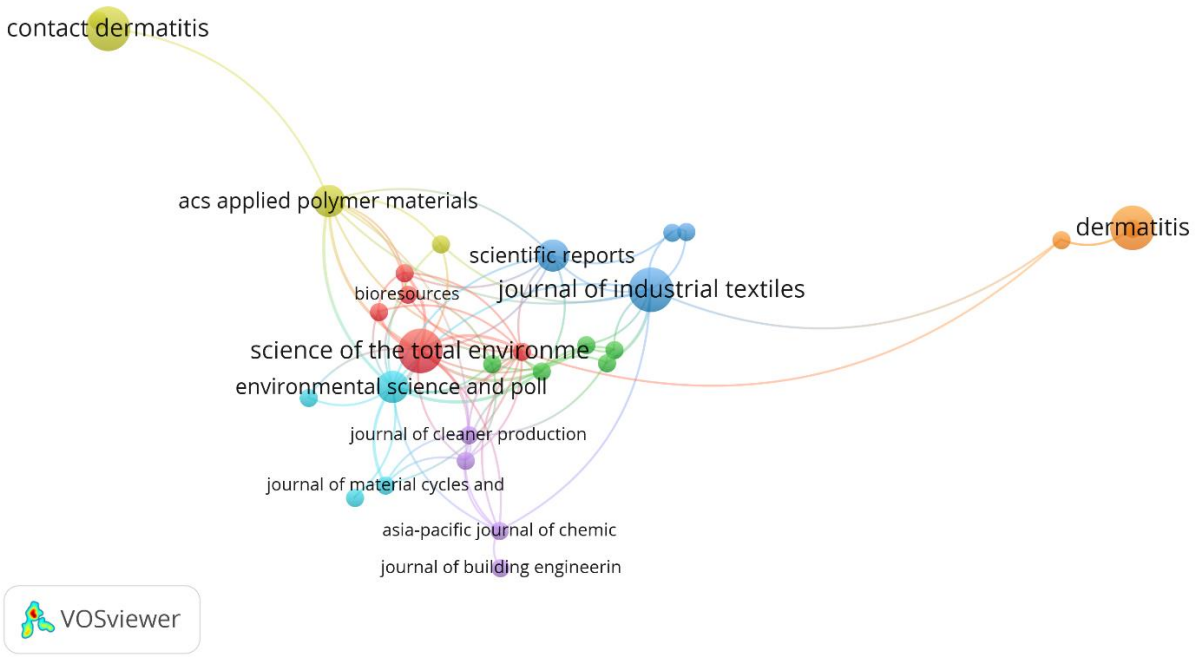

Fig. 5. Journals most prominent for publishing research on wet wipes

The variety of keywords related to wet wipes is shown in Fig. 6. In particular, the predominant keywords were: wet wipes, methylisothiazolinone, plastic pollution, water, degradation, allergic contact dermatitis. Until 2020–2021, research focused more intensively on the safety of wet wipes for human health and their composition, whereas from 2021 onward, studies on environmental pollution and degradation of wet wipes (including biodegradation) have become increasingly prominent (Fig. 6).

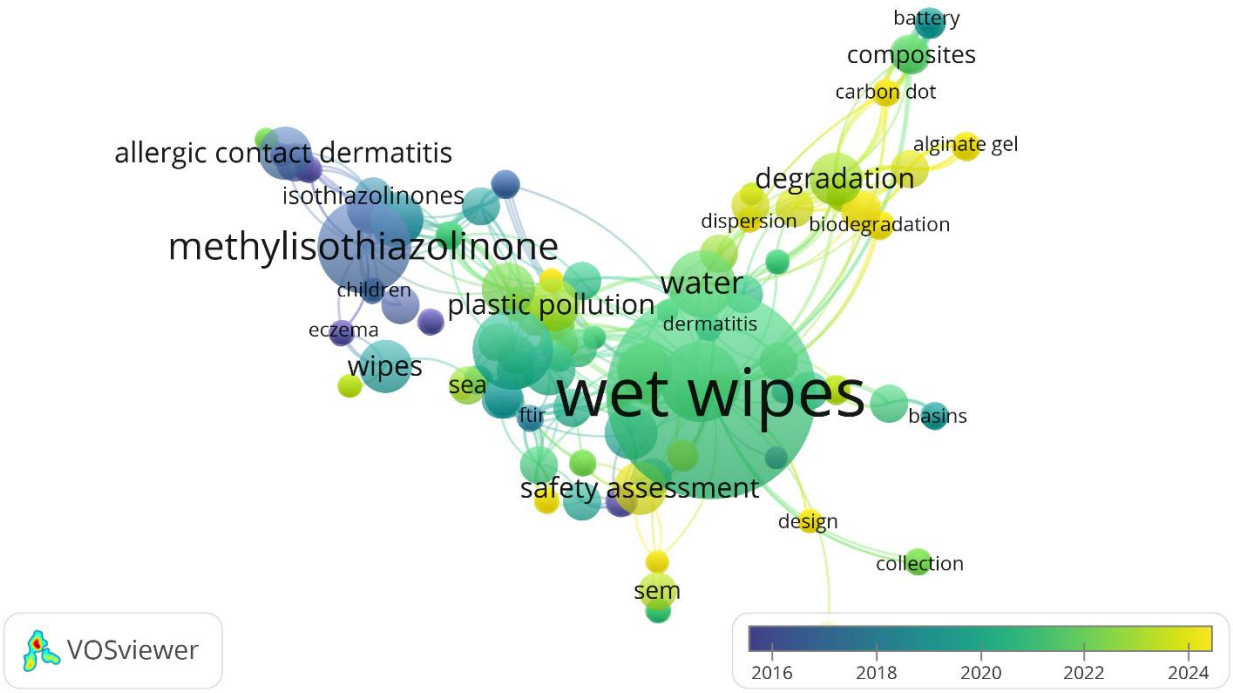

Fig. 6. Trends by year in the application of keywords concerning wet wipes

Antibacterial properties of wet wipes

Wet wipes are disposable daily products for hygienic purposes, in particular, the removal of pathogenic microorganisms from biotic and abiotic surfaces. Among the publications available to us, a number are devoted to studying the sensitivity of model micro-organisms to solutions used in wet wipes, i.e. their antibacterial properties to improve the storage conditions of this hygienic product (Yayla et al., 2021; Salama et al., 2021). Antibacterial properties of wet wipes are given by preservatives that are added to the mixtures to moisturize them (Siegert, 2011; Salama et al., 2021). However, wet wipes used in medical facilities are not always active in practice and may be ineffective, which requires stricter labelling control and appropriate efficacy tests (Siani et al., 2011; Seenama et al., 2013). Among the 19 tested antibacterial wipes available on the Ukrainian market, 4 (21.0 %) did not have sufficient antimicrobial activity. Given the results obtained, it is better to use antimicrobial wet wipes from well-known manufacturers, purchased in pharmacy chains (Lekhniuk et al., 2020).

The solutions used to wet the wipe material contain a variety of compounds, including, for example, methylisothiazolinone (Tkachuk & Hrytsenko, 2025) – a pesticide employed to control slime-forming bacteria, fungi, and algae in pulp and paper mills, water-cooling systems, oilfield operations, industrial process water, and air purification systems, and also used as a preservative in adhesives, coatings, fuels, metalworking fluids, resin emulsions, paints, and various other specialty industrial products (United States…, 1998). Methylchloroisothiazolinone and methyliso-thiazolinone are preservatives, contact allergens, strong sensitizers that can cause contact dermatitis. It is proposed to limit their use in the European Union (EU) for leave-on cosmetics (including wet wipes). Nevertheless, in leave-on cosmetic products, such as «wet wipes», the safe levels of methylisothiazolinone with respect to contact allergy have not been adequately determined. These compounds are recom-mended for use only in rinse-off products (Regulation (EC) No 1223/2009…, 2009; Castanedo-Tardana and Zug, 2013; Chang and Nakrani, 2014; Scientific Committee on Consumer Safety…, 2014).

Also, the moisturizing solution for wet wipes may contain compounds such as benzalkonium chloride, benzyl alcohol, amyl cinnamal, butylphenylmethylpropional (Lilial), retinyl palmitate (vitamin A). Some features of the sanitary and hygienic characteristics of these compounds are as follows:

- Benzalkonium chloride. This substance is reported to irritate the skin, eyes, and respiratory passages. It is also toxic to aquatic and soil organisms. It is a quaternary ammo-nium salt, preservative, disinfectant, and sanitizer (Lee & Park, 2019; Liao et al., 2023).
- Benzyl alcohol. It is a solvent and preservative that can cause contact dermatitis, and in infants at high doses can cause «gasping syndrome». Although it is used in cosmetics in small concentrations (McCloskey et al., 1986; PubChem…, n.d.).
- Amyl cinnamal. It is a perfume allergen, a skin sensitizer (Australian Government…, 2016). Amyl cinnamal is included in the list of 26 EU fragrance allergens. The list above comprises 26 allergens identified by the European Commission as the most frequent causes of fragrance-induced contact dermatitis (Scientific Committee…, 2012). The use of this compound is governed by Regulation (EC) No 1223/2009 on cosmetic products, particularly Annex III (List of substances prohibited in cosmetic products unless used within specified limits), which requires manufacturers to declare the ingredient on the packaging if its concent-ration exceeds 0.001 % in leave-on products or 0.01 % in rinse-off products (Regulation (EC) No 1223/2009…, 2009). This list is intended to allow consumers to identify possible fragrance allergens from the labeling.
- Butylphenylmethylpropional (Lilial). This compound is a perfume allergen, a possible sensitizer, classified as reprotoxic (Repr. 1B) in the EU (Scientific Committee…, 2012, 2019). It is noted that in the EU, hygiene and cosmetic products containing this compound are prohibited from March 1, 2022 (Cosmetics Care…, n.d.).
- Retinyl palmitate (vitamin A). This is an antioxidant that is safe in small doses, but in excess may exhibit teratogenic properties (Ritchie, 1998).

The role of triclosan-containing antibacterial cleaning and hygiene products in promoting antibiotic resistance, a growing public health issue, As highlighted by Aiello and Larson (2003), a limited understanding by manufacturers of the complex chemical composition of biocides and their effects on antimicrobial efficacy – combined with improper use, incorrect dilution, or insufficient contact time – can result in microbial tolerance or resistance and may even contribute to the development of resistance, including antibiotic resistance (Maillard & Pascoe, 2024).

Wet wipes are toxic according to biotesting results with the plant *Lepidium sativum* (Tkachuk & Zelena, 2023a; Tkachuk & Hrytsenko, 2025) and a small planktonic crustacean *Daphnia magna* (Erdoğan, 2025).

Formulations based on plant extracts with antimicrobial activity are being developed to reduce the toxicity of wetting mixtures (Ferreira et al., 2022; Stefi et al., 2022; Subashini et al., 2024). A biocontrol strategy has also been proposed for disinfecting hard surfaces in hospitals using microbial-based wipes, by producing dry wipes containing adequate amounts of beneficial bacteria or spores (Dural-Erem et al., 2017). Once hydrated, these wipes can discharge beneficial bacteria that inhibit pathogens by establishing and proliferating on the surfaces (Dural-Erem et al., 2017).

Thus, the antimicrobial properties of wet wipes for medical and household use are actively being studied, but they do not always meet sanitary and hygienic requirements, which is dangerous from a public health perspective in the form of a risk of the appearance of pathogens and the possible development of infections. The proposed formulations of mixtures for wetting wet wipes based on plant extracts and beneficial bacteria can solve the issue of eco- and biosafety of these hygiene products.

Bacterial contamination of new wet wipes

The issue of bacterial contamination of wet wipes is also important for monitoring compliance with hygiene rules (Chong, 2016). In particular, the method of bacterial culture established bacterial contamination in 9 types of disposable wet wipes provided by restaurants, and its absence in the remaining 23 types (71.9 %) (Chong, 2016). Disposable wet wipes were found to contain *Staphylococcus haemolyticus, S. hominis, S. warneri,* and *Pseudomonas fluorescens,* while methicillin-resistant coagulase-negative staphylococci and multidrug-resistant bacteria were absent (Chong, 2016).

Kang et al. (2023) isolated *Pseudomonas aeruginosa* from 238 new wet wipes tested in two variants (0.8 %), with an average count of 9.9×10^2 CFU per towel; *Escherichia coli* and *Staphylococcus aureus* were not detected in any sample. Although the *P. aeruginosa* isolates did not exhibit antibiotic resistance, they carried the *toxA* gene and could potentially infect immunocompromised individuals, leading to pathogenic effects. *P. aeruginosa*, a Gram-negative bacterium commonly found in soil and water and part of the normal skin microbiota, can cause a wide range of infections, including skin diseases, keratitis, and peritonitis, particularly in people with weakened immune systems. Contamination of wet wipes may occur due to inadequate personal hygiene during packaging (Kang et al., 2023).

A large outbreak of *P. aeruginosa* ST3875 in Norway (October 2021 – June 2022) was linked to contaminated disposable wipes, affecting nearly 400 patients across 40 hospitals. The median patient age was 70 years, predominantly in intensive care units or other vulnerable populations. Clinically severe infection occurred in 25 % of cases, and *P. aeruginosa* infection was considered a contributing factor in several deaths. Similar products were available in healthcare and care settings in Scotland, and investigations are ongoing into their potential link to cases and outbreaks. These findings underscore the importance of raising awareness among healthcare professionals and ensuring the withdrawal of affected products, especially in healthcare environments (NSS Health…, 2023).

Moreover, Nkemngong et al. (2020) demonstrated that although wipes containing hydrogen peroxide and quaternary ammonium disinfectants exhibited some sporicidal activity, they still retained *Clostridioides difficile* spores (the causative agent of often fatal infections) during and after wiping. This enabled the transfer of *C. difficile* spores from contaminated to previously uncontaminated surfaces.

Information regarding the microbial composition of new wet wipe surfaces is presented in Table 2.

Table 2

Bacterial diversity of the surface of new wet wipes

A species of bacteria	Risk group*	Reference
Staphylococcus haemolyticus	2	(Chong, 2016)
Staphylococcus hominis	2	(Chong, 2016)
Staphylococcus warneri	2	(Chong, 2016)
Pseudomonas fluorescens	1	(Chong, 2016; Kang et al., 2023; NSS Health…, 2023)

Note: * According TRBA 466… (2015)

Thus, new wet wipes may be contaminated with infectious agents, requiring stricter microbiological control of these products and, possibly, their labelling for pathogen-free testing.

Bacterial contamination of used wet wipes

Currently, information on the microbial diversity of discarded wet wipe surfaces is limited. This topic has only recently gained research attention, particularly due to the increasing human health risks associated with the persistence of pathogens such as Escherichia coli on wet wipe surfaces (Metcalf et al., 2024). Faecal indicator organisms, including *E. coli* and *Vibrio* species, were more frequently detected on wet wipes littering the beaches of the Fourth Estuary than on seaweed (Metcalf et al., 2022). Additionally, four potentially pathogenic *Vibrio* species (*V. alginolyticus, V. parahaemolyticus, V. cholerae*, and *V. vulnificus*) were identified on wet wipes, and some isolated bacteria exhibited resistance to multiple antibiotics (Metcalf et al., 2022). Consequently, the accumulation of used wet wipes as litter represents a potential threat to human health.

Table 3 presents the microbial diversity found on the surface of used wet wipes.

Table 3

Bacterial diversity of the surface of used wet wipes

A species of bacteria	Risk group*	Reference
Escherichia coli	2	(Metcalf et al., 2022; Metcalf et al., 2024)
Vibrio alginolyticus	2	(Metcalf et al., 2022)
Vibrio parahaemolyticus	2	(Metcalf et al., 2022)
Vibrio cholerae	2	(Metcalf et al., 2022)
Vibrio vulnificus	2	(Metcalf et al., 2022)

Note: * According TRBA 466… (2015)

Effect of wet wipes microbiome on natural microbial communities

Microorganisms that constitute the microbiome of hygiene product surfaces, in addition to being potential pathogens, can also influence the functioning of natural environmental microbial communities. For example, exogenous *Escherichia coli* has been shown to impact benthic archaeal and bacterial communities, altering symbiotic interactions, including mutual regulation and the integration of multiple environmental functions, as well as affecting elemental cycling (Gu et al., 2021). It was observed that exposure to *E. coli* induced feedback responses in benthic prokaryotic communities, influencing both microbial community structure and geochemical functions.

Representatives of the genus *Pseudomonas*, which produce secondary metabolites, affect competition sensing, antagonistic interactions, and modified secondary metabolites production (Hansen, 2021). The ability of *Pseudomonas fluorescens* to mobilize inorganic phosphate in soils is known (Browne et al., 2009) as well as ability to remove total oil hydrocarbons of a soil (Gutiérrez et al., 2020). In

general, *P. fluorescens* is characterized by significant bioremediation potential (Alsukaibi et al., 2023).

Staphylococcus aureus is able to metabolize phosphorus compounds (Kelliher et al., 2020) and to form biofilms (Hu et al., 2023; Liang et al., 2023).

E. coli, S. aureus, Pseudomonas spp. Participate in the Sulphur cycle and biotransformation of metals (Plante, 2007). It should be noted that the ecological and physiological group of anaerobic sulphate-reducing bacteria (SRB) is also involved in the sulphur cycle in soils and aquatic environments (Plante, 2007). However, at the moment, there are no reports of the detection of representatives of this group of prokaryotes on the surface of wet wipes that have become garbage. Since SRB are active biodegraders found in the biofilm on the surfaces of materials known to be involved in the biodegradation processes of plastics (Cacciari et al., 1993; McCormick et al., 2014; Pinnell and Turner, 2019; Abdulina et al., 2021; Tang et al., 2022; Tkachuk and Zelena, 2023b), their presence and diversity on the surface of hygiene products that have become waste should be investigated for possible use in biotechnological processes of disposal of these pollutants.

Therefore, the identified microorganisms on wet wipes are involved in the cycling of carbon, nitrogen, phosphorus, and sulfur; however, most belong to risk group 2 and cannot be considered suitable for bioremediation.

Environmental aspects associated with wet wipes

A range of environmental problems associated with wet wipe production and usage is shown in Fig. 7.

Therefore, the main environmental issues associated with wet wipes are (Ó Briain et al., 2020; Tkachuk et al., 2024; Shruti et al., 2021; Zhang et al., 2022):

- environmental accumulation of wet wipes, leading to water and soil contamination;
- enhanced greenhouse gas emissions;
- elevated levels of microplastics in the environment;
- operational problems in wastewater systems.

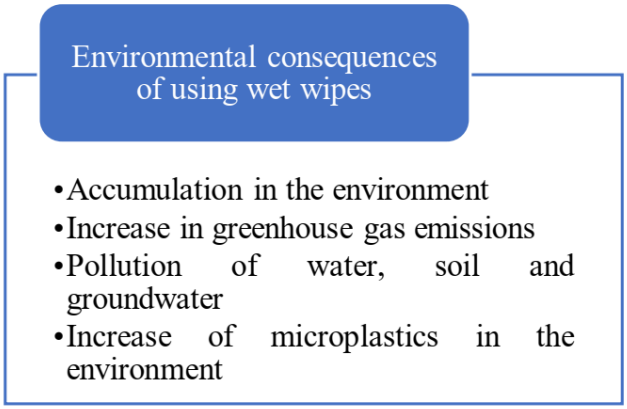

Fig. 7. Ecological problems linked to the use of wet wipes (Tkachuk and Zelena, 2023b)

Addressing the environmental issues related to wet wipes requires the use of eco-friendly, biodegradable materials and non-toxic wetting solutions, which necessitates innovative production technologies. Equally important is fostering consumer awareness regarding proper disposal of wet wipes (Tkachuk et al., 2024; The Rivers Trusts, n.d.).

Social aspects of the use of wet wipes in a public health context

Today, the wet wipes market is significant, with global baby wipe sales rising from USD 4.1 billion in 2018 to USD 16.83 billion in 2020 and projected to reach USD 17.98 billion by 2026 at a CAGR of 6.3% (2021–2026) (Ramya et al., 2021). This growth underscores the increasing environmental and health impacts of these products, emphasizing the need for responsible use. The above-mentioned problems with wet wipes can be solved by joint efforts of politicians, manufacturers and retailers, water supply companies and the general public. Education and public involvement are key to

solving the problem of wet wipes (Zhang et al., 2021; The Rivers Trusts, n.d.).

Young people have significant potential to act as catalysts for change and to raise awareness of environmental issues (Torres et al., 2019). Promoting environmental care and respect is further supported through preventive environmental education programs, which shape individual behavior and enhance people's capacity and motivation to adopt environmentally responsible practices (Torres et al., 2019). Currently, approximately 25 % of students in grades 8–9 at Chernihiv Gymnasium No. 32 (Ukraine) reported having thrown wet wipes into the wrong trash bin, highlighting a lack of awareness regarding recycling and the resulting pollution of the city's green areas with this hygiene product (Tkachuk & Zahryva, 2025). Mitigating the environmental impact of wet wipes requires a systemic approach encompassing production, consumption, and disposal processes. Consumer behavior, influenced by 12 factors, plays a key role in determining the waste flow of wet wipes. These factors are grouped into three categories: «consumption habits», «cost», and «incentives». Among them, «time consumption» was identified as the most significant, suggesting that convenient solid waste management infrastructure is an effective measure to reduce environmental leakage. Researchers also emphasize that raising awareness about the plastic content of wet wipes – such as by including this information on packaging – is a practical strategy (Zhang et al., 2022).

Advocacy and educational activities aimed at raising awareness about the issue of wet wipes are carried out by The Rivers Trusts (The Rivers Trusts, n.d.). The Plastic Free Mersey project, managed by the Mersey Rivers Trust and Thames21, employs brand survey data to impact the plastics and recycling industry (The Rivers Trusts, n.d.).

A major gap in environmental education regarding critical aspects of daily human behavior drives the negative influence of numerous actions on sustainable development (Alonso-Sainz, 2021). Achieving the Sustainable Development Goals is closely related to the issues of biological and environmental safety of wet wipes (Fig. 8), in particular, with Goal 3 - Good health and well-being (Tkachuk and Zahryva, 2025), which includes, among other things, ending epidemics of major infectious diseases and reducing risk factors associated with environmental pollution (Eurostat, n.d.).

Fig. 8. Sustainable Development Goals addressing environmental issues associated with wet wipes (Tkachuk & Zahryva, 2025) (Figure adapted by us)

A generalized analysis of the effects of wet wipes on selected ecological and public health indicators

In general, the importance of knowledge about the number and diversity of bacteria on hygiene products waste in both terrestrial and marine environments is as follows (Rakhmawati et al., 2024):

- has significant potential for understanding and solving current environmental and public health problems;

▪can help assess their environmental impact and potential impact on ecosystems;

▪can encourage responsible disposal practices;

▪can promote the use of environmentally friendly materials to minimize the impact on the environment;

▪can offer valuable information about their degradation processes in the modern ecological context.

Therefore, wet wipes are a product that can affect the following public health indicators:

1) environmental – safety of consumer products, environmental risks to health, environmental quality, which is associated with the content of compounds in their wetting solutions that can cause allergies, are toxic, as well as the fact that they are a source of microplastics;

2) medical and sanitary - the level of morbidity, which is associated with the facts of non-compliance of a number of wet wipes with sanitary and hygienic standards – their ineffective antibacterial properties, the presence of pathogens and antibiotic-resistant strains;

3) social and behavioural – consumer behaviour of the population, which is associated with the formation of a conscious attitude towards the use and disposal of used wet wipes, appreciating the importance of increasing their biological and environmental safety.

Conclusions

Based on a bibliometric review of the literature and available studies, the human health and environmental risks linked to wet wipe use were thoroughly analyzed. In general, the quality of wet wipes and their consumption by the population can determine such public health indicators as environmental, medical and sanitary, social and behavioural. Microbiological and environmental parameters that determine the safety of wet wipes for public health have become the subject of comprehensive scientific analysis. The study emphasizes pathogenic indicator microorganisms as potential health hazards and considers the environmental impact of pollution caused by this hygiene product. However, socio-pedagogical approaches aimed at forming a responsible attitude towards the use and proper disposal of wet wipes remain underdeveloped and not systematic. Future research should focus on:

▪further exploring the microbial diversity of hygiene products, considering both harmful microorganisms and potential biodegraders;

▪search for eco- and bio-safe materials and solutions for wetting wet wipes;

▪shaping the behaviour of responsible use and consumption of wet wipes.

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References

Abdulina, D.R., Chuenko, A.I., Topchiy, A.S., Kopteva, G.E., & Kopteva, Zh.P. (2021). Ability of sulfate reducing bacteria to utilize polymer and rubber materials. *Mikrobiol. Z., 83*(2), 51-63. https://doi.org/10.15407/microbiolj83.02.051

Aiello, A.E., & Larson, E. (2003). Antibacterial cleaning and hygiene products as an emerging risk factor for antibiotic resistance in the community. *Lancet Infect. Dis.*, *3*(8), 501-506. https://doi.org/10.1016/s1473-3099(03)00723-0

Allison, T., Ward, B.D., Harbottle, M., & Durance, I. (2023). Do flushed biodegradable wet wipes really degrade? *Sci. Total. Environ. 894*, 164912. https://doi.org/10.1016/j.scitotenv.2023.164912

Alonso-Sainz, T. (2021). Educación para el desarrollo sostenible: Una visión crítica desde la Pedagogía. *Rev. Complut. Educ. 32*, 249–259. https://doi.org/10.5209/rced.68338

Alsukaibi, A.K.D., Mechi, L., Alimi, F.R., Alshamari, A.K.A.A., Alshammari, E.M., Otaibi, A.A., Sherwani, S., & Khan, M.W.A. (2023). Bioremediation potential of *Pseudomonas fluorescens* strain isolated from the Ha'il region of Saudi Arabia. *Bioinformation*, *19*(9), 901-907. https://doi.org/10.6026/97320630019901

Angulo-Pineda, C., Lu, J.R., Cartmell, S., & McBain, A.J. (2025). Compositional factors driving antibacterial efficacy in healthcare wet wipe products. *Front. Microbiol., 16*, 1582630. https://doi.org/10.3389/fmicb.2025.1582630

Australian Government Department of Health. National Industrial Chemicals Notification and Assessment Scheme. (2016). *Amyl and hexyl cinnamaldehyde: Human health tier II assessment* https://www.industrialchemicals.gov.au/sites/default/files/Amyl%20and%20hexyl%20cinnamaldehyde_Human%20health%20tier%20II%20assessment.pdf

Bondaroff, T.Ph., & Cooke, S. (2020). *Masks on the Beach: The impact of COVID-19 on marine plastic pollution*. OceansAsia. https://oceansasia.org/wp-content/uploads/2020/12/Marine-Plastic-Pollution-FINAL.pdf

Browne, P., Rice, O., Miller, S.H., Burke, J., Dowling, D., Morrissey, J., & O'Gara, F. (2009). Superior inorganic phosphate solubilization is linked to phylogeny within the *Pseudomonas fluorescens* complex. *Appl. Soil Ecol., 43*(1), 131–138. https://doi.org/10.1016/j.apsoil.2009.06.010

Cacciari, I., Quatrini, P., Zirletta, G., Mincione, E., Vinciguerra, V., Lupattelli, P., & Giovannozzi Sermanni, G. (1993). Isotactic polypropylene biodegradation by a microbial community: physicochemical characterization of metabolites produced. *Appl. Environ. Microbiol.*, *59*(11), 3695-700. https://doi.org/10.1128/aem.59.11.3695-3700.1993

Cao, Z., Yan, W., Ding, M., & Yuan, Y. (2022). Construction of microbial consortia for microbial degradation of complex compounds. *Front. Bioeng. Biotechnol., 10,* 1051233. https://doi.org/10.3389/fbioe.2022.1051233

Cardiff University. (2008). *Antibacterial Wipes Can Spread Bacteria Around.* ScienceDaily. www.sciencedaily.com/releases/2008/06/080603133410.htm

Castanedo-Tardana, M.P., & Zug, K.A. (2013). Methylisothiazolinone. Dermatitis, *24*(1), 2-6. https://doi.org/10.1097/DER.0b013e31827edc73

Chang, M.W., & Nakrani, R. (2014). Six children with allergic contact dermatitis to methylisothiazolinone in wet wipes (baby wipes). *Pediatrics*, *133*(2), e434-8. https://doi.org/10.1542/peds.2013-1453

Cheng, K.L., Boost, M.V., & Chung, J.W. (2011). Study on the effectiveness of disinfection with wipes against methicillin-resistant *Staphylococcus aureus* and implications for hospital hygiene. *Am. J. Infect. Control, 39*(7), 577-580. https://doi.org/10.1016/j.ajic.2010.08.024

Chong, M. (2016). Bacterial Contamination in Disposable Wet Wipes from General Restaurants. *J. Clin. Lab. Sci., 48*, 237-241. https://doi.org/10.15324/kjcls.2022.54.1.23

Cosmetics Care. (n.d.). *Safety Assessment* https://www.cosmeticscare.eu/en/?s=lilial

Dural-Erem, A., Wessman, P., Husmark, U., & Nierstrasz, V. (2017). Biocontrol of solid surfaces in hospitals using microbial-based wipes. *Text. Res. J.*, *89*(2), 216-222. https://doi.org/10.1177/0040517517741163

Environmental and economic costs of disposable wet wipes, menstrual products and baby diaper. (n.d.). https://zerowastelviv.org.ua/wp-content/uploads/2021/06/ua_doslidzhennya-pidguzky.pdf (in Ukrainian)

Екологічні та економічні витрати від одноразових вологих серветок, менструальних засобів та дитячих підгузків. Режим доступу: https://zerowastelviv.org.ua/wp-content/uploads/2021/06/ua_doslidzhennya-pidguzky.pdf (дата звернення: 17 листопада 2025)

Erdoğan Ş. (2025). Acute Toxic effects of Disposable Personal Hygiene Products on *Daphnia magna. Afyon Kocatepe Üniversitesi Fen Ve Mühendislik Bilimleri Dergisi, 25*(1), 47-52. https://doi.org/10.35414/akufemubid.1509243

Eurostat. (n.d.). *Sustainable Development Goals. 3. Good health and well-being* https://ec.europa.eu/eurostat/web/sdi/database/good-health-and-well-being

Ferreira, G.D.S., da Silva, D.J., Zanata, L., Souza, A. G., Ferreira, R.R., & Rosa, D. S. (2022). Antimicrobial cotton wipes functionalized with *Melaleuca alternifolia* Pickering emulsions stabilized with cellulose nanofibrils. *Carbohydr. Polym. Technol. Appl., 3*, 100208. https://doi.org/10.1016/j.carpta.2022.100208

Gu, L., Wu, J.Y., & Hua, Z.L. (2021). Benthic prokaryotic microbial community assembly and biogeochemical potentials in *E. coli* – Stressed aquatic ecosystems during plant decomposition. *Environ. Pollut.*, *275,* 116643. https://doi.org/10.1016/j.envpol.2021.116643

Gutiérrez, E.J., Abraham, M.D.R., Baltazar, J.C., Vázquez, G., Delgadillo, E., & Tirado, D. (2020). *Pseudomonas fluorescens*: A Bioaugmentation Strategy for Oil-Contaminated and Nutrient-Poor Soil. *Int. J. Environ. Res. Public Health.*, *17*(19), 6959. https://doi.org/10.3390/ijerph17196959

Hansen, M.L. (2021). Control of microbial soil communities by *Pseudomonas*-produced secondary metabolites. [PhD thesis]. Technical University of Denmark, Kongens Lyngby. https://backend.orbit.dtu.dk/ws/portalfiles/portal/282189434/PhD_thesis.pdf

Harter, T., Steiner, H., & Hirn, U. (2022). Investigating mechanisms deteriorating the dispersibility of biodegradable and flushable wet wipes. *Cellulose*, *29,* 8827–8842. https://doi.org/10.1007/s10570-022-04816-y

Hu, P., Sharaby, Y., Gu, J., Radian, A., & Yona, N.L. (2023). Biogeochemical cycles and health implications potentially mediated by active dust-borne bacteria. *Authorea*, 1-18. https://doi.org/10.22541/au.169261441.14767355/v1

Kang, J., Sung, M., Kim, J.H., & Yoonm, Y. (2023). Pretreatments for Microbial Analysis and Evaluation of Hygiene of Wet Towels and Wet Wipes. *J. Pure Appl. Microbiol*., *17*(2), 780-787. https://doi.org/10.22207/JPAM.17.2.03

Kelliher, J.L., Leder Macek, A.J., Grudzinski, K.M., Radin, J.N., & Kehl-Fie, T.E. (2020). *Staphylococcus aureus* preferentially liberates inorganic phosphate from organophosphates in environments where this nutrient is limiting. *J. Bacteriol*., *202,* e00264-20. https://doi.org/10.1128/JB.00264-20

Khalid, M., & Abdollahi, M. (2021). Environmental Distribution of Personal Care Products and Their Effects on Human Health. *Iran J. Pharm. Res*., *20*(1), 216-253. https://doi.org/10.22037/ijpr.2021.114891.15088

Khalid, S.A., & Elsherif, W.M. (2022). Types of Microorganisms for Biodegradation. In G.A.M. Ali & A.S.H. Makhlouf (Eds.), *Handbook of Biodegradable Materials*. Springer. https://doi.org/10.1007/978-3-030-83783-9_2-1

Khan, M.S., Yang, K., Liu, Z., Zhou, L., Liu, W., Lin, S., Wang, X., & Shang, C. (2023). Microorganisms Involved in the Biodegradation and Microbiological Corrosion of Structural Materials. *Coatings*, *13,* 1683. https://doi.org/10.3390/coatings13101683

Kyrychenko, O.V., Hnitii, N.V., & Bidna, K.A. (2020). Market of wet wipes in Ukraine. Modern Materials Science and Commodity Science: Theory, Practice, Education. Proceedings of the VII International Scientific and Practical Internet Conference (2020 Mar 12–13, Poltava, Ukraine). pp. 84-87. https://core.ac.uk/download/pdf/326487599.pdf (in Ukrainian)

Кириченко О. В., Гнітій Н. В., Бідна К. А. Ринок серветок вологих в Україні. Сучасне матеріалознавство та товарознавство: теорія, практика, освіта : матеріали VII Міжнародної науково-практичної інтернет-конференції (12–13 березня 2020 року, м. Полтава). Полтава : ПУЕТ, 2020. С. 84-87. Режим доступу: http://dspace.puet.edu.ua/handle/123456789/8698 (дата звернення: 17.11.2025)

Lee, H., & Park, K. (2019). Acute toxicity of benzalkonium chloride in Balb/c mice following intratracheal instillation and oral administration. *Environ. Anal. Health Toxicol*., *34*(3), e2019009. https://doi.org/10.5620/eaht.e2019009

Lekhniuk, N., Mykytiuk, S., Konechna, R., Shykula, R., Korniychuk, O., & Konechnyi, Y. (2020). Comparative analysis of antimicrobial and fungicidal activity of commonly available hand sanitizers and antibacterial wet wipes on Ukrainian market. *Proc. Shevchenko Sci. Soc. Med. Sci., 59*(1), 100-110. https://doi.org/10.25040/ntsh2020.01.08 (in Ukrainian).

Лехнюк Н., Микитюк С., Конечна Р., Шикула Р., Корнійчук О., Конечний Ю. Дослідження протимікробної та протигрибкової дії антисептиків для рук та антибактеріальних вологих серветок доступних на ринку України. *Праці Наукового товариства імені Шевченка. Медичні науки.* 2020. Т. 59, № 1. С. 100-110. https://doi.org/10.25040/ntsh2020.01.08

Liang, J., Huang, T.Y., Mao, Y., & Li, X. (2023). Biofilm formation of two genetically diverse *Staphylococcus aureus* isolates under beta-lactam antibiotics. *Front. Microbiol., 14,* 1139753. https://doi.org/10.3389/fmicb.2023.1139753

Liao, M., Wei, S., Zhao, J., Wang, J., & Fan, G. (2023). Risks of benzalkonium chlorides as emerging contaminants in the environment and possible control strategies from the perspective of ecopharmacovigilance. *Ecotoxicol. Environ. Saf*., *266*, 115613. https://doi.org/10.1016/j.ecoenv.2023.115613

Lin, N. (2023). Chemicals in personal care products: an important but understudied exposure source for both the human body and ecosystems. *J. Environ. Expo Assess*., *2*, 19. https://doi.org/10.20517/jeea.2023.31

Lumio, R.T., Tan, M.A., & Magpantay, H.D. (2021). Biotechnology-based microbial degradation of plastic additives. *3 Biotech.*, *11*(7), 350. https://doi.org/10.1007/s13205-021-02884-8

Maillard, J.Y., & Pascoe, M. (2024). Disinfectants and antiseptics: mechanisms of action and resistance. *Nat. Rev. Microbiol*., *22*, 4–17. https://doi.org/10.1038/s41579-023-00958-3

McCloskey, S.E., Gershanik, J.J., Lertora, J.J., White, L., & George, W.J. (1986). Toxicity of benzyl alcohol in adult and neonatal mice. *J. Pharm. Sci*., *75*(7), 702-705. https://doi.org/10.1002/jps.2600750718

McCormick, A., Hoellein, T.J., Mason, S.A. Schluep, J., & Kelly, J.J. (2014). Microplastic is an abundant and distinct microbial habitat in an urban river. *Environ. Sci. Technol*., *48*, 11863–11871. https://doi.org/10.1021/es503610r

Metcalf, R., Fellows, R., White, H.L., & Quilliam, R.S. (2024). Persistence of "wet wipes" in beach sand: An unrecognised reservoir for localised *E. coli* contamination. *Mar. Pollut. Bull*., *201,* 116175. https://doi.org/10.1016/j.marpolbul.2024.116175

Metcalf, R., White, H.L., Moresco, V. Ormsby, M.J., Oliver, D.M., & Quilliam, R.S. (2022). Sewage-associated plastic waste washed up on beaches can act as a reservoir for faecal bacteria, potential human pathogens, and genes for antimicrobial resistance. *Mar. Pollut. Bull*., *180*, 113766. https://doi.org/10.1016/j.marpolbul.2022.113766

Nkemngong, C.A., Chaggar, G.K., Li, X., Teska, P.J., & Oliver, H.F. (2020). Disinfectant wipes transfer *Clostridioides difficile* spores from contaminated surfaces to uncontaminated surfaces during the disinfection process. *Antimicrob. Resist. Infect. Control*., *9*, 176. https://doi.org/10.1186/s13756-020-00844-0

NSS Health Facilities Scotland: SAN2205. (2023). *Recall of hygiene products associated with Pseudomonas aeruginosa infection*. https://www.nss.nhs.scot/media/2737/safety-action-notice-san2205.pdf

Ó Briain, O., Marques Mendes, A.R., McCarron, S., Healy, M.G., & Morrison, L. (2020). The role of wet wipes and sanitary towels as a source of white microplastic fibers in the marine environment. *Water Res., 182,* 116021. https://doi.org/10.1016/j.watres.2020.116021

Pinnell, L.J., & Turner, J.W. (2019). Shotgun metagenomics reveals the benthic microbial community response to plastic and bioplastic in a coastal marine environment. *Front. Microbiol., 10,* 1252. https://doi.org/10.3389/fmicb.2019.01252

Plante, A.F. (2007). Soil biogeochemical cycling of inorganic nutrients and metals. In E.A. Paul (Ed.), *Soil Microbiology, Ecology and Biochemistry* (3rd ed., pp. 389-432). Academic Press. https://doi.org/10.1016/B978-0-08-047514-1.50019-6

PubChem Compound Database. National Library of Medicine. National Center for Biotechnology Information (n.d.). *Benzyl alcohol.* https://pubchem.ncbi.nlm.nih.gov/compound/benzyl%20alcohol

Rakhmawati, A., Octavia, B., Marwati, S., & Kristanti, D. (2024). Bacterial profiling of mask waste from terrestrial and marine environment. *Global J. Environ. Sci. Manage., 10*(4), 1-18. https://www.gjesm.net/article_713073_27dec80cced13ef57031d459410b6ac6.pdf

Ramya, K., & Amutha, K. (2021). Eco-friendly wet wipes - A review. *Proceedings of the International Conference on Advances in Technical Textiles* (2021 October; Sathyamangalam, Tamilnadu, India). https://5.imimg.com/data5/SELLER/Doc/2023/9/343153030/WV/GB/VZ/140877384/baby-wet-wipes.pdf

Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products (recast). (2009). Official Journal of the European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02009R1223-20250901

Ritchie, H.E., Webster, W.S., Eckhoff, C., & Oakes, D.J. (1998). Model predicting the teratogenic potential of retinyl palmitate, using a combined *in vivo/in vitro* approach. *Teratology*, *58*(3-4), 113-123. https://doi.org/10.1002/(SICI)1096-9926(199809/10)58:3/4<113::AID-TERA7>3.0.CO;2-O

Salama, P., Gliksberg, A., Cohen, M., Tzafrir, I., & Ziklo, N. (2021). Why Are Wet Wipes So Difficult to Preserve? Understanding the Intrinsic Causes. *Cosmetics*, *8*(3), 73. https://doi.org/10.3390/cosmetics8030073

Scientific Committee on Consumer Safety. (2012). *Opinion on fragrance allergens in cosmetic products (SCCS/1459/11)*. European Commission. https://ec.europa.eu/health/scientific_committees/consumer_safety/docs/sccs_o_102.pdf

Scientific Committee on Consumer Safety. (2019). *Opinion on the safety of Butylphenyl methylpropional (p-BMHCA) in cosmetic products – Submission II (SCCS/1591/17).* European Commission. https://health.ec.europa.eu/system/files/2021-08/sccs_o_213_0.pdf

Scientific Committee on Consumer Safety. (2014). *Revision of the opinion on Methylisothiazolinone (P94) Submission II (Sensitisation only) (SCCS/1521/14).* European Commission. https://health.ec.europa.eu/publications/revision-opinion-methylisothiazolinone-p94-submission-ii-sensitisation-only_en

Seenama, C., Tachasirinugune, P., Jintanothaitavorn, D., Kachintorn, K., & Thamlikitkul, V. (2013). Effectiveness of disinfectant wipes for decontamination of bacteria on patients' environmental and medical equipment surfaces at Siriraj Hospital. *J. Med. Assoc. Thai.,* 96 Suppl 2, S111-6. http://www.jmatonline.com/PDF/S111-S116-PB-96-S2.pdf

Shruti, V.C., Pérez-Guevara, F. & Kutralam-Muniasamy, G. (2021). Wet wipes contribution to microfiber contamination under COVID-19 era: An important but overlooked problem. *Environ. Chall.*, *5*, 100267. https://doi.org/10.1016/j.envc.2021.100267

Siani, H., Cooper, C., & Maillard, J.Y. (2011). Efficacy of «sporicidal» wipes against *Clostridium difficile. Am. J. Infect. Control.*, *39*(3), 212-218. https://doi.org/10.1016/j.ajic.2011.01.006

Siegert, W. (2011). Preservative Trends in Wet Wipes. *SOFW-J.*, *137*, 44–51. https://www.researchgate.net/publication/232273400_Preservative_Trends_in_Wet_Wipes

Song, X., Vossebein, L., & Zille, A. (2019). Efficacy of disinfectant-impregnated wipes used for surface disinfection in hospitals: a review. *Antimicrob. Resist. Infect. Control.*, *8*, 139. https://doi.org/10.1186/s13756-019-0595-2

Stefi, S.M., Joseph, J., Shamya, A.M., Kumar, V.R., Suresh, A., & Thirunavukarasu, R. (2022). Evaluation and formulation of antiseptic herbal hand wipes. *Asia-Pac. J. Pharmacother. Toxicol.*, *2*, 11-17. https://doi.org/10.32948/ajpt.2022.12.30

Subashini, P., Thilak B., Preetika, S., & Niranjanasree, A.C. (2024). Formulation and evaluation of herbal wet wipes using non-woven fabrics. *J. med. Pharm. Allied Sci., 13-I 4*, 6713–6716. https://doi.org/10.55522/jmpas.V13I4.6614

Sülar, V., & Keçeci, B. (2021). Degradation of nonwoven fabrics suitable for wet wipes buried in soil. *TexTen X: Proceedings of the International Conference on Textiles and Connected R & D Domains* (2021 October 21-22; Bucharest, Romania). https://doi.org/10.35530/TT.2021.53

Tang, M., Zhou, S., Huang, J., Sun, L., & Lu, H. (2022). Stress responses of sulfate-reducing bacteria sludge upon exposure to polyethylene microplastics. *Water Res., 220,* 118646. https://doi.org/10.1016/j.watres.2022.118646

The Rivers Trusts (n.d.). *Wet Wipes Position Statement*. https://theriverstrust.org/about-us/our-position-statements/wet-wipes-position-statement

Tkachuk, N.V., & Hrytsenko, O.M. (2025). Ecological and medical-biological risks of using antibacterial wet wipes. *Transformational approaches to sustainable development: environmental education, science and environmental practices for the reconstruction of Ukraine: Abstracts of the International Scientific and Practical Conference* (2025 Sep 22-26; Zhytomyr, Ukraine). Zhytomyr Polytechnic Institute. p. 38. https://conf.ztu.edu.ua/wp-content/uploads/2025/10/38.pdf

Tkachuk, N., & Zahryva, D. (2025). Wet wipes in green ecosystems of Chernihiv, Ukraine. *CIMS*, *4*(1), 139-144. https://doi.org/10.15421/cims.4.268

Tkachuk, N., & Zelena L. (2023a). Evaluation of the Toxicity of Wet Wipes Based on the Growth Test with *Lepidium sativum* L. *Eng. Proc., 56*(5). https://doi.org/10.3390/ASEC2023-15495

Tkachuk, N., & Zelena, L. (2023b). Some Microbiological Characteristics of the Biofilm on the Surface of Pre-Production Pellets of Polypropylene Microplastics after Short Exposure in Soil. *Eng. Proc., 56*(1), 1-4. https://doi.org/10.3390/ASEC2023-15350

Tkachuk, N., Zelena, L., & Novikov, Ya. (2024). Wet wipes as a cause of environmental problems: a mini review. *Selected Papers of VI International Conference on European Dimensions of Sustainable Development* (2024 May 15–17, Kyiv, Ukraine). NUFT. pp. 88-94. https://doi.org/10.24263/EDSD-2024-6-12

Torres, H.R., Reynolds, C.J., Lewis, A., Muller-Karger, F., Alsharif, K., & Mastenbrook, K. (2019). Examining youth perceptions and social contexts of litter to improve marine debris environmental education. *Environ. Educ. Res*., *25*, 1400–1415. https://doi.org/10.1080/13504622.2019.1633274

TRBA 466. (2015). *Einstufung von Prokaryonten (Bacteria und Archaea) in Risikogruppen*. https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRBA/pdf/TRBA-466.pdf?__blob=publicationFile&v=4

United States Environmental Protection Agency. (1998). *Methylisothiazolinone. Prevention, pesticides and toxic substances (7508C)*. EPA-738-F-98-008. https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/fs_G-58_1-Oct-98.pdf

VOSviewer. (n.d.). https://www.vosviewer.com/

WHO Regional Office for Europe. (2022). *A health perspective on the role of the environment in One Health. WHO Regional Office for Europe*. https://iris.who.int/bitstream/handle/10665/354574/WHO-EURO-2022-5290-45054-64214-eng.pdf

Yayla, O., Özgeç, M., Ay, E., Gençtürk, Ü., & İnce, A. (2021). Application of Anti-Bacterial Feature to Wet Wipes Made of Cellulosic Fibre Based. *Biol. Chem. Res.*, *8*, 80-96. https://www.ss-pub.org/wp-content/uploads/2021/07/BCR2021032901.pdf

Zhang, Yu., Wen, Z., Hu, Yu., & Zhang, T. (2022). Waste flow of wet wipes and decision-making mechanism for consumers' discarding behaviors. *J. Clean. Prod.*, *364*, 132684. https://doi.org/10.1016/j.jclepro.2022.132684

Zhang, Y., Wen, Z., Lin, W., Hu, Y., Kosajan, V., & Zhang, T. (2021). Life-cycle environmental impact assessment and plastic pollution prevention measures of wet wipes. *Resour. Conserv. Recycl.*, *174*, 105803. https://doi.org/10.1016/j.resconrec.2021.105803

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Information about the authors:

Tkachuk N. [*in Ukrainian*: **Ткачук Н.] [1],** Cand. Sc. (Biol.), Assoc. Prof., email: nataliia.smykun@gmail.com
ORCID: 0000-0002-5115-7716 *Scopus-Author ID*: 7801574248 *ResearcherID:* AAB-4448-2020
Department of Biology and Human Health, T.H. Shevchenko National University «Chernihiv Colehium»
53 Hetmana Polubotka Street, Chernihiv, 14013, Ukraine

Zelena L. [*in Ukrainian*: **Зелена Л.] [2]**, Cand. Sc. (Biol.), Senior Researcher, email: zelenalyubov@gmail.com
ORCID: 0000-0002-5148-1030 *Scopus-Author ID*: 6506970298 *ResearcherID:* H-7309-2013
Department of Virus Reproduction, Danylo Zabolotny Institute of Microbiology and Virology, NAS of Ukraine
154 Akademika Zabolotnoho Street, Kyiv, 03680, Ukraine

Shkardybarda I. [*in Ukrainian*: **Шкардибарда І.] [3]**, PhD student, email: ivanshkardybarda@gmail.com
ORCID: 0009-0007-3557-3561
Department of Biology and Human Health, T.H. Shevchenko National University «Chernihiv Colehium»
53 Hetmana Polubotka Street, Chernihiv, 14013, Ukraine

Nikolaienko D. [*in Ukrainian*: **Ніколаєнко Д.] [4]**, PhD student, email: dmitry.nikolayenko@gmail.com
ORCID: 0009-0007-9262-9779
Department of Biology and Human Health, T.H. Shevchenko National University «Chernihiv Colehium»
53 Hetmana Polubotka Street, Chernihiv, 14013, Ukraine

Demchenko N. [*in Ukrainian*: **Демченко Н.] [5]**, Cand. Sc. (Biol.), Assoc. Prof., email: nata_demch@ukr.net
ORCID: 0000-0001-8542-730X *Scopus-Author ID*: 57190674891
Department of Biology and Human Health, T.H. Shevchenko National University «Chernihiv Colehium»,
53 Hetmana Polubotka Street, Chernihiv, 14013, Ukraine

[1] Study design, data collection, statistical analysis, manuscript preparation.
[2] Manuscript preparation.
[3] Data collection, statistical analysis.
[4] Data collection, statistical analysis.
[5] Manuscript preparation.