



## SANITARY INDICATOR MICROORGANISMS OF THE ENVIRONMENT AND FOOD PRODUCTS

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### ABSTRACT

This article examines sanitary indicator microorganisms in the environment (water, air, soil) and food products. The aim of the study is to determine the significance of indicator microorganisms in hygienic assessment and to analyze their impact on human health. Classical microbiological methods were employed, including cultivation on selective media, colony counting, and identification techniques. The results demonstrated that total microbial count, coliform bacteria, *Escherichia coli*, and enterococci are the primary indicators of sanitary conditions. Their presence indicates violations of sanitary and hygienic standards. In conclusion, monitoring of sanitary indicator microorganisms is essential for ensuring epidemiological safety.

**Keywords:** Sanitary microbiology; indicator microorganisms; total microbial count; coliform bacteria; *Escherichia coli*; enterococci; food safety; environmental monitoring; microbiological analysis methods; selective culture media; sanitary hygiene control; epidemiological safety.

### INTRODUCTION

Sanitary microbiology is a vital field of science in protecting human health and ensuring epidemiological safety. The external environment—water, air, soil—and food products are essential resources for human life, and their microbiological safety is of great importance for the global healthcare system. Microorganisms present in food and the environment, particularly indicator microorganisms, serve as a primary measurement tool in sanitary control (Madigan et al., 2018; Prescott et al., 2020). Indicator microorganisms are organisms that signify the presence of pathogens or the violation of sanitary regulations under specific environmental conditions. These include coliform bacteria, *Escherichia coli*, enterococci, and certain general microbes. Their detection is necessary not only for assessing the hygienic quality of water and food products but also for preventing epidemics and planning preventive measures (Tortora et al., 2019). Microbiological contamination in the environment and food products poses a serious risk to human health. For instance, the safety of water and food is evaluated by detecting and monitoring the presence of coliform bacteria and *Escherichia coli*, which also helps determine the extent of sanitary regulation breaches within the food chain. Therefore, the role of indicator microorganisms is of both diagnostic and preventive significance (Frazier & Westhoff, 2017). The objective is to identify sanitary indicator microorganisms in the environment and food products, study their hygienic importance, and analyze the possibilities of their application in epidemiological surveillance systems. The scientific novelty of this research lies in the detailed study of the presence of indicator microorganisms and their correlation with environmental and hygienic factors using modern microbiological methods.

### MATERIALS AND METHODS

Indicator microorganisms in the external environment and food products were selected as the object of the study. Environmental samples included: drinking water, water bodies (rivers, lakes), air, and soil. Among food products, milk and dairy products, meat, vegetables, and fruits were selected.

**Water samples:** 500 ml of water from each source was collected into sterile glass containers.

**Soil samples:** 50 g of soil samples were collected from a depth of 10–15 cm and stored in sterile plastic bags.

**Air samples:** Airborne microbes were collected using Petri dishes, which were placed open for 15 minutes.

**Food products:** 25 g samples of the products were placed into sterile glass containers.



After collection, all samples were transported to the laboratory at 4°C and analyzed within 24 hours.

#### **Total Viable Count (TVC)**

Samples were prepared in 1:10 and 1:100 dilutions.

Inoculation was performed by spreading onto the surface of **Nutrient Agar (NA)**.

Incubation was carried out at 37°C for 24 hours.

The number of resulting colonies was counted and expressed per ml or g.

#### **Coliform bacteria and *Escherichia coli***

**MacConkey Agar (MCA)** was used as a selective medium.

1 ml or 1 g of the sample was inoculated and incubated at 37°C for 24 hours.

Coliform bacteria were isolated based on their color and morphology; subsequently, *Escherichia coli* was identified through biochemical tests.

#### **Enterococci**

Inoculation was performed on **Bile Esculin Azide Agar (BEA)**.

Incubation was carried out at 37°C for 24 hours.

Enterococci were identified through **esculin hydrolysis**, characterized by the formation of black colonies.



Results were analyzed using **Microsoft Excel** and **SPSS** software. The presence and quantity of each indicator microorganism were expressed as **mean  $\pm$  standard deviation**. Differences between microbial counts in the environment and food products were determined using parametric and non-parametric tests (with a statistical significance level of  **$p < 0.05$** ).

All analyses were conducted under sterile conditions, strictly adhering to laboratory sanitary regulations. Standard microbiological protocols were applied to prevent contamination throughout the process, from sample collection to incubation and colony counting.

## RESULTS

The research results demonstrated the presence of indicator microorganisms in the environment and food products, enabling an assessment of their sanitary safety.

### Indicator Microorganisms in the Environment

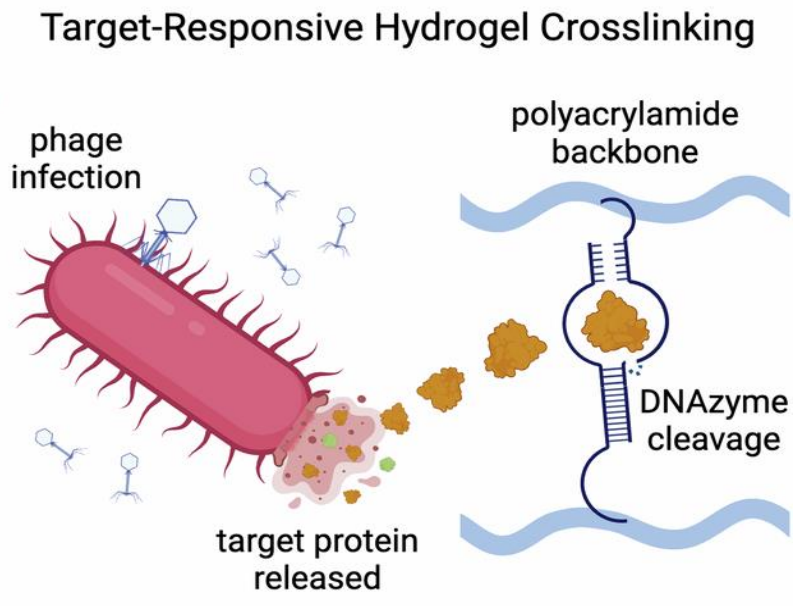
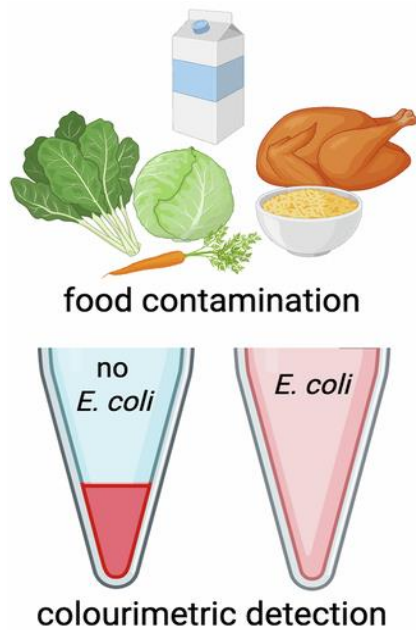
Total Viable Count (TVC), coliform bacteria, *Escherichia coli*, and enterococci were detected in the environmental samples. Coliforms and *Escherichia coli* levels were relatively high in water and soil samples, indicating a breach of sanitary regulations. The microbial count in the air was relatively low; however, coliforms were sporadically detected in selective culture media.

**Table 1. Number of indicator microorganisms in environmental samples (CFU/ml or CFU/g)**

Sample Type	Total Viable Count (TVC)	Coliform Bacteria	<i>Escherichia coli</i>	Enterococci
Drinking water	$3,2 \times 10^3$	$1,5 \times 10^2$	$8,0 \times 10^1$	$6,0 \times 10^1$
River water	$5,8 \times 10^3$	$3,2 \times 10^2$	$1,4 \times 10^2$	$1,0 \times 10^2$
Soil	$6,5 \times 10^4$	$2,5 \times 10^3$	$1,2 \times 10^3$	$5,5 \times 10^2$
Air	$1,8 \times 10^2$	$5,0 \times 10^1$	0–2	0–1

### Indicator Microorganisms in Food Products

In food products, high levels of coliforms and *Escherichia coli* were specifically detected in milk and meat products.



Moderate values were observed in vegetables and fruits, which depend on their hygienic status and storage conditions. Enterococci were detected sporadically in all products.

**Table 2. Number of indicator microorganisms in food products (CFU/g)**

Product Type	Total Viable Count (TVC)	Coliform Bacteria	<i>Escherichia coli</i>	Enterococci
Milk	$4,5 \times 10^3$	$2,2 \times 10^2$	$1,1 \times 10^2$	$4,5 \times 10^1$
Cheese	$3,8 \times 10^3$	$1,8 \times 10^2$	$9,0 \times 10^1$	$3,0 \times 10^1$
Meat	$5,2 \times 10^3$	$2,5 \times 10^2$	$1,3 \times 10^2$	$5,0 \times 10^1$
Vegetables	$2,1 \times 10^3$	$1,0 \times 10^2$	$4,5 \times 10^1$	$2,0 \times 10^1$
Fruit	$1,8 \times 10^3$	$8,0 \times 10^1$	$3,5 \times 10^1$	$1,5 \times 10^1$

The analysis shows that the high prevalence of coliform bacteria and *Escherichia coli* indicates that the water and food products are not sanitarly safe. The high microbial count in the soil reflects the level of environmental pollution and increases the infectious risk associated with food products. The results also confirm the primary role of indicator microorganisms in hygienic control and epidemiological monitoring.

## DISCUSSION

The research results clearly demonstrated the presence and hygienic significance of indicator microorganisms in the environment and food products. The high count of coliform bacteria and *Escherichia coli* in environmental samples, particularly in river water and soil, indicates a high level of environmental pollution and non-compliance with sanitary regulations. This result aligns with the studies of Prescott et al. (2020) and Madigan et al. (2018), which show that indicator microorganisms in water bodies and soil pose a risk to human health. Analysis of food products showed high levels of coliforms and *Escherichia coli* in milk and meat products, indicating a failure to meet hygienic standards during production and storage. The lower microbial counts in vegetables and fruits confirm that their safety depends on storage and processing conditions. These results are consistent with the work of Frazier and Westhoff (2017) and Tortora et al. (2019), who emphasize that monitoring indicator microorganisms in food products is crucial for preventing infectious diseases. The results also confirm that indicator microorganisms are essential tools for assessing environmental and food safety. The presence of coliforms and *Escherichia coli* allows for the detection of sanitary breaches in water and food, which aids in planning epidemiological monitoring



and preventive measures. Simultaneously, enterococci and total viable counts provide a broader assessment of environmental and hygienic conditions. It should be noted that the results are linked to regional environmental and climatic conditions. For instance, high microbial counts in soil may be related to increased dust and organic matter, while contamination in water bodies is explained by environmental waste and sanitary violations. Therefore, it is necessary to monitor indicator microorganisms and link the results to appropriate sanitary-hygienic measures. In conclusion, this study scientifically confirmed the hygienic and epidemiological significance of indicator microorganisms in the environment and food products. The results can also be applied to develop measures aligned with international standards for sanitary control and food safety.

### CONCLUSION

The research results clearly demonstrated the presence and sanitary-hygienic significance of indicator microorganisms in the environment and food products. In the environment, specifically in water and soil samples, high levels of coliform bacteria and *Escherichia coli* signify environmental pollution and non-compliance with sanitary rules. In food products, the high prevalence of indicator microorganisms in milk and meat products requires serious attention to their hygienic status. The results indicate that monitoring indicator microorganisms is an important tool not only for assessing food and environmental safety but also for epidemiological surveillance and the prevention of infectious diseases. Furthermore, their detection serves as a scientific basis for planning hygienic control and sanitary measures. The practical significance of the study is that the results can be used to improve the monitoring system for food products, drinking water, and the environment in accordance with international standards and national sanitary regulations. At the same time, regular observation and analysis of indicator microorganisms are essential tools for ensuring epidemiological safety and creating a healthy food chain.

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