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IDENTIFICATION OF CHANGES IN THE TOTAL NUMBER OF MICROORGANISMS IN THE SOIL OF TERMEZ CITY WHEN AN ELEVATED COLI-INDEX IS DETECTED DURING MICROBIOLOGICAL ANALYSIS

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Abstract

This paper presents the results of a microbiological analysis of soil samples collected from the territory of Termez city (Uzbekistan). It was found that in samples with a high coliform index (more than 1000 coliform bacteria/kg), the total microbial count (TMC) significantly decreases compared to conditionally clean areas. An inverse correlation between the studied parameters was revealed. It is concluded that fecal contamination of soil under the climatic conditions of Termez leads to the suppression of saprophytic microbiota, which must be taken into account when assessing soil sanitation.

Keywords

Total microbial count (TMC), coliform index, coliform bacteria, soil, Termez, microbiological analysis, fecal contamination.

Introduction

Microbiological indicators of soil are among the main criteria of its sanitary and hygienic condition. Among them, two are of key importance: the total microbial count (TMC), reflecting the total content of saprophytic microorganisms in 1 g of soil, and the coliform index — the number of coliform bacteria in 1 kg of soil, which directly indicates fecal contamination. For clean soils, the coliform index usually does not exceed 1–10 coliform bacteria/kg, while for conditionally clean soils, sanitary standards permit up to 1000 coliform bacteria/kg. Exceeding this level indicates fresh fecal contamination and potential epidemic danger.

The city of Termez is located in southern Uzbekistan, in a dry subtropical zone. The soils are sierozems (gray soils) experiencing high anthropogenic pressure due to dense building development, inadequate sewage systems, and active agricultural use. Preliminary data showed that in some areas of Termez, the coliform index significantly exceeds the norm. However, the effect of this factor on the total microbial count of the city's soils has not been previously studied.

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The aim of this work is to identify changes in the total number of microorganisms in the soil of Termez when an elevated coliform index is detected during microbiological analysis.

Methods and Results

Methods. The study was conducted in April–May 2023. Soil samples were taken from three characteristic zones of Termez: Zone 1 — the coastal zone of the Surkhandarya River (conditionally clean control); Zone 2 — a residential sector with individual houses and cesspools (potential fecal contamination); Zone 3 — the territory of the city market (high anthropogenic load). In each zone, 10 samples were collected from the top layer (0–10 cm) using sterile tools.

The coliform index was determined by the titration method on Kessler's medium, followed by subculturing onto lactose-peptone medium. Results were expressed as coliform bacteria per 1 kg of soil. The total microbial count was determined by plating soil suspension (dilutions from 10^{-1} to 10^{-6}) on meat-peptone agar, incubated at 37 °C for 48 hours. Results were expressed as colony-forming units per 1 g of absolutely dry soil (CFU/g). Statistical processing was performed by calculating arithmetic means, standard errors, and Pearson's correlation coefficient.

Results. In the control (coastal) zone, the coliform index averaged 12 coliform bacteria/kg, corresponding to clean soil. The total microbial count here was 4.8×10^6 CFU/g — a typical value for uncontaminated sierozems. In the residential sector (Karasu area), the coliform index was significantly elevated: 1450 coliform bacteria/kg, which is 120 times higher than the control and exceeds the permissible level for conditionally clean soils. At the same time, the total microbial count decreased to 2.1×10^6 CFU/g — 2.3 times less than in the control. On the market territory, the coliform index was 680 coliform bacteria/kg (moderate exceedance), and TMC was 3.3×10^6 CFU/g, which is 1.45 times lower than the control value.

Correlation analysis of all 30 samples revealed a moderate negative relationship between the coliform index and TMC: Pearson's coefficient $r = -0.67$ ($p < 0.01$). Thus, as the coliform index increases, the total microbial count significantly decreases.

Discussion

The obtained results show that a high coliform index in the soils of Termez is accompanied by a decrease in the total microbial count. This at first glance contradicts the expectation that fecal contamination should enrich the soil with organic matter and stimulate the growth of all microorganisms. However, there are several explanations.

First, fecal matter contains not only coliform bacteria but also toxic products of ammonification (ammonia, amines), which in high concentrations inhibit many saprophytic bacteria. Second, Escherichia coli produces bacteriocins (colicins) that inhibit the growth of gram-positive saprophytes, which usually form the basis of TMC. Third, under the hot, dry climate of Termez, the introduction of feces leads to rapid drying and salinization of the topsoil, which is detrimental to most aerobic saprophytes, whereas coliform bacteria, as facultative anaerobes, are more resistant.

Furthermore, in residential areas with cesspools, local anaerobic conditions often develop. Aerobes that are part of the saprophytic microflora die, while facultatively anaerobic coliform bacteria survive and even multiply. This leads to a paradoxical situation: the higher the fecal contamination, the lower the total number of microbes, but the epidemic risk increases.

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Comparison with literature data shows that in soils of temperate climates, a high coliform index is often accompanied by an increase in TMC due to the coliform bacteria themselves and associated putrefactive bacteria. However, for the arid zones of Central Asia (Tajikistan, Turkmenistan, Uzbekistan), an inverse relationship is characteristic, which is confirmed by isolated studies.

The practical significance of the obtained data lies in the fact that when assessing the sanitation of soils in Termez, one cannot rely solely on TMC — under conditions of fecal contamination, it may be deceptively low. Both indicators must be determined in combination, and regional features must be taken into account.

Conclusion

Based on the conducted microbiological analysis of soil in Termez city, the following conclusions can be drawn:

In the residential sector with individual houses (Karasu area), a high coliform index of 1450 coliform bacteria/kg was detected, which significantly exceeds sanitary standards and indicates chronic fecal contamination.

In the same samples, the total microbial count was reduced by 2.3 times compared to the conditionally clean coastal zone.

A negative correlation was established between the coliform index and the total microbial count ($r = -0.67$; $p < 0.01$).

For adequate sanitary-microbiological assessment of soils in Termez, it is recommended to use a composite indicator that includes both the coliform index and TMC, taking into account local climatic conditions.

A perspective for further research is to study the species composition of saprophytic microorganisms in areas with a high coliform index and to assess the antibiotic resistance of isolated coliform bacteria.

Literature Review

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