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MICROBIAL QUALITY OF AIR IN VARIOUS SEASONS UNDER THE INFLUENCE OF EMISSIONS FROM SEWAGE TREATMENT PLANT

The study was performed in the area adjacent to the municipal sewage treatment plant in Gorzów Wielkopolski. The tests carried out in order to determine total bacteria and fungi as well as the population of indicator bacteria (actinomycetes, *Escherichia coli* and *Pseudomonas fluorescens*) in 1 m^3 of air. The results obtained and statistical analysis revealed that both selected factors (season and localization of sampling points) had a great influence on the population of microorganisms tested. Bacteria, fungi and, to a smaller extent, actinomycetes were the most serious air pollutants. Bioaerosols emitted from sewage-treatment plants also contained *Escherichia coli* and *Pseudomonas fluorescens* bacteria.

1. INTRODUCTION

Municipal sewage-treatment plants that treat surface water may be a serious threat for environment [1], [2]. They, among others, deteriorate the quality of the atmospheric air. The range of their influence depends on many factors, e.g., type, quality and amount of sewage, object size, exploitation method, treatment technology, as well as on weather conditions such as velocity and direction of a wind, temperature and rainfalls [3]–[6]. Besides volatile organic compounds, gases or scent agents, the bioaerosols that introduce microorganisms, often pathogenic ones, into the atmosphere, are one of the most serious pollutants [7]–[11].

The aim of the research was to evaluate the influence of bioaerosols emitted from mechanical-biological sewage treatment plants on the microbial quality of atmospheric air in the vicinity of such plants.

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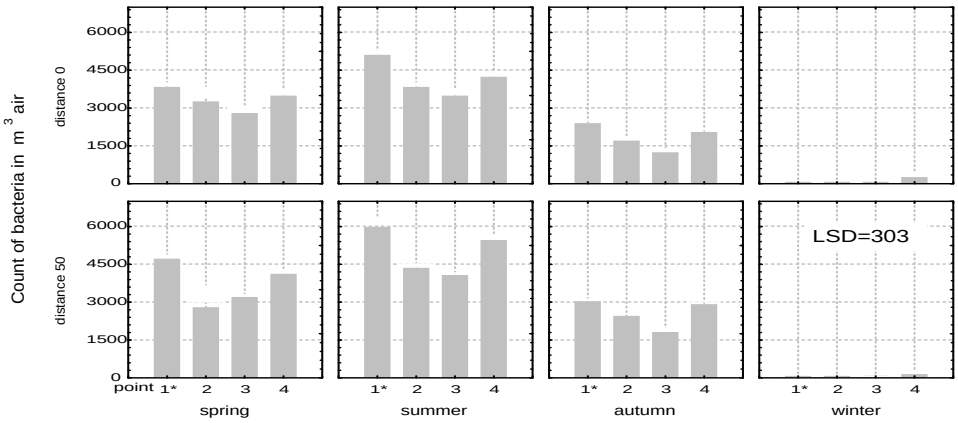
2. MATERIAL AND METHODS

The area adjacent to municipal sewage treatment plant in Gorzów Wielkopolski was under study. The plant is situated at western town border, north direction from the road to Kostrzyn, in a trough surrounded by woods. It has been operating since 1979 treating municipal and industrial sewage. It has also been supplied with waste transported by cars from the town areas lacking sewage system and the neighbouring areas.

The weather conditions were determined on a basis of the data collected in particular study periods. In order to evaluate the pollution of air with microorganisms in a direct neighbourhood of the treatment plant and in distant zones, eight sampling points were found [12]. Four of them were localized directly at particular objects (S-W, W, E and N-W), and four other – 50 m away. Air pollution with microorganisms throughout seasons was determined by sedimentation method (according to PN-89/Z-04008.08). The studies dealt with determining a total population (CFU – colony-forming units) of bacteria and fungi, as well as the indicator bacteria, i.e., actinomycetes, *Escherichia coli* and *Pseudomonas fluorescens* in 1 m^3 of air. The results obtained were statistically processed applying variance analysis and Duncan's test.

3. RESULTS AND DISCUSSION

The results obtained and statistical analyses revealed that both selected factors (season and localization of sampling points) significantly influenced the population of the microorganisms studied in the vicinity of mechanical-biological treatment plant (figure 1).



* 1- 4 sampling points

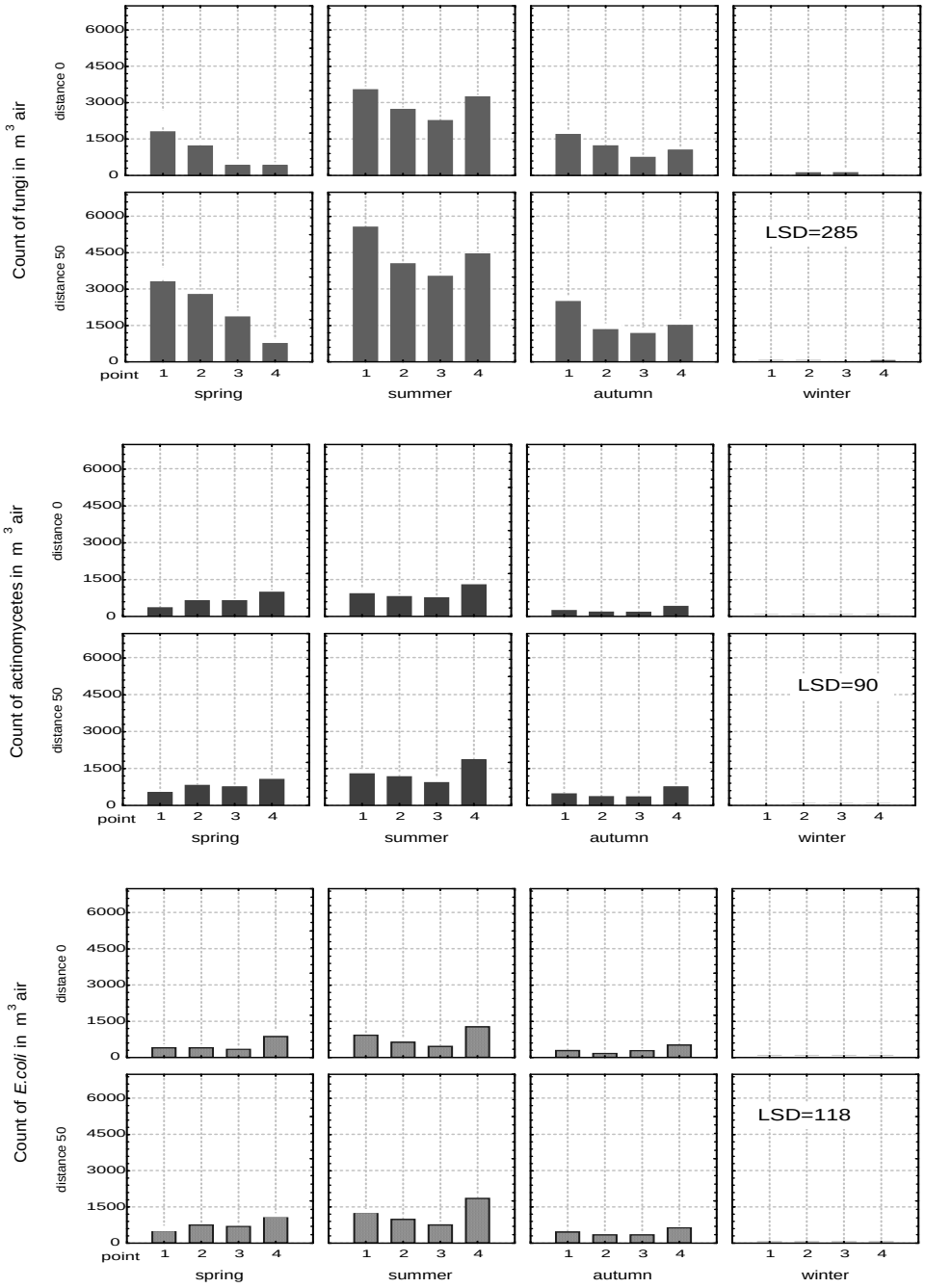


Fig. 1. Number of microorganisms in the air in the vicinity of sewage treatment plant

Bacteria, fungi and, to a smaller extent, actinomycetes were the most serious pollutants. Bioaerosols emitted from the plant contained *Escherichia coli* and *Pseudomonas fluorescens* bacteria.

The microorganisms of particular groups occurred in the highest density in summer when almost half of population was observed, then in spring (over 30%), in autumn (20%) and several per cent in winter (figure 2). The seasonal differences in the pollution of air with microorganism, i.e., their increase in warmer seasons, were also recorded by NOWAK et al. [10]. Sampling points No. 4 and No. 1 as well as No. 2 were the most polluted areas adjacent to the treatment plant. The lowest population number was found at the sampling point No. 3, regardless of the microorganism group (figure 1, the table). The number of microorganisms in the air in treatment plant was most often similar to that in the air at the points lying 50 meters away from the plant.

However, in the case of fungi, their significant (LSD = 599) population increase, i.e., by 768 CFU per 1 m^3 of air (on average), was observed in the second series of sampling points being at some distance from the treatment plant. Similar trends were detected for actinomycetes and *Escherichia coli* populations, but they were not confirmed statistically. MALINOWSKA and MARSKA [4] achieved similar results, since they found the size of the fungi population to increase at a longer distance from the emitter.

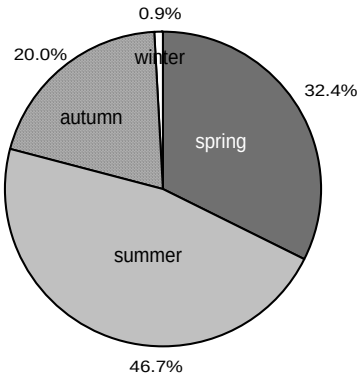


Fig. 2. Percentage of microorganism populations in the air in the vicinity of sewage treatment plant in various seasons

Taking into account the standards for fungi population in the air, it can be considered moderately clean in spring and autumn, but polluted in summer when their number exceeds 500 thousand of CFU per 1 m^3. Such a number of fungi may negatively affect the natural environment. Because we found only several or slightly more *Pseudomonas fluorescens* bacteria in 1 m^3 of air, which makes 50 and less in terms of standards, the air should be considered moderately polluted regardless of season. A total number of bacteria present in the air in the vicinity of the treatment plant in summer and in spring allows us to classify the air as strongly polluted, but it is moderately polluted in autumn. Based on the number of actinomycetes in the air and a huge number of *E. coli* bacteria from

spring to autumn it can be concluded that these values in terms of standards are too high. The most favourable sanitary conditions in the vicinity of the sewage treatment plant occur in winter. Along with the temperature drop the number of microorganisms in the air decrease to value much lower than the standard for clean air. Taking into account the wind direction, no significant increase in the population size of the microorganism tested was found in the air at a leeward side of the plant.

Table

Mean share of microorganisms in the air in the vicinity of sewage treatment plant at selected sampling points (CFU per 1 m^3 of air)

Experimental point	Bacteria	Fungi	*Actinomycetes*	*E. coli*	*Pseudomonas fluorescens*
1 (S-W)	3236	2455	529	543	10
2 (W)	2461	1752	525	453	11
3 (E)	2167	1355	472	393	7
4 (N-W)	2964	1486	840	840	10

A significant increase in the population size was more closely associated with the localization of sampling points (in particular, points No. 4 and No. 1), i.e., in the places being direct sources of bioaerosols, e.g., basins and reservoirs for preliminary sewage treatment, the roads leading from the source of sewage to the treatment plant as well as sewage waste dump. An increase in the bioaerosols concentration in the vicinity of the treatment plant, including the places at the shortest distance from biostabilization chambers and sedimentation plots, was observed by FILIPOWSKA et al. [1]. Similar concentration was also reported by GAJEWSKA and REKOSZ-BURLAGA [2] near sewage channel and by MALINOWSKA and MARSKA [6] near aeration chambers.

Though the permissible concentration of air pollutants in the vicinity of the treatment plant in Gorzów Wielkopolski is frequently exceeded, the localization of the plant in a trough surrounded by woods should be considered to be favourable to the reduction of their influence on environment. Such specific conditions probably may allow us to retain large amounts of bioaerosols and thus to reduce their spreading. In a direct contact, such aerosols may be a main threat to people.

4. CONCLUSIONS

The permissible number of microorganisms, including pathogenic ones, in the atmospheric aerosols in the vicinity of mechanical-biological sewage treatment plant are often exceeded. The pollution of air with microorganisms depends on the season and localization of the sampling point.

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MIKROBIOLOGICZNA JAKOŚĆ POWIETRZA W RÓŻNYCH PORACH ROKU W REJONIE ODDZIAŁYWANIA EMISJI Z OCZYSZCZALNI ŚCIEKÓW

Badaniami objęto teren wokół oczyszczalni ścieków komunalnych w Gorzowie Wielkopolskim. W 1 m^3 powietrza oznaczano ogólną liczebność bakterii i grzybów, a także bakterii wskaźnikowych, tj. promieniowców, pałeczki okrężnicy (*Escherichia coli*) oraz bakterii *Pseudomonas fluorescens.* Na podstawie otrzymanych wyników i przeprowadzonej analizy statystycznej stwierdzono, że zarówno wybrane czynniki, tj. pora roku, jak i lokalizacja wybranych punktów badawczych miały istotny wpływ na liczebność badanych mikroorganizmów. Największe zanieczyszczenie stanowiły bakterie oraz grzyby, a następnie promieniowce. Bioaerozole emitowane przez oczyszczalnie ścieków zawierały pałeczki okrężnicy (*Escherichia coli*) oraz bakterie *Pseudomonas fluorescens*.