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# MICROBIOLOGICAL ANALYSIS OF BIOAREOSOL IN FOOD INDUSTRY

## ANALIZA MIKROBIOLOGICZNA BIOAEROZOLU W ZAKŁADACH PRZEMYSŁU SPOŻYWCZEGO

**Abstract:** Presence of bacteria and fungi in the food processing plants influence on quality and stability of products. Fungal contaminants are especially dangerous because fungi produce mycotoxins and allergens. The aim of this study was assessed microbial contamination of the air in food industry and determining the dominance of bacteria or fungi in various closed spaces. The bioaerosol was tested by the Koch sedimentation method by using Petri dishes (90 mm) which were located hight at 1.3 m and incubated 15 min. Air analysis was performed in various closed spaces: production hall (HP, HP3, HP4), aseptic production hall (AC, AU), packing department (PD), cloak rooms (CL i CM1, CM2), two production storages (PS1, PS2), technical storage (TS) and canteen (CA). The results were given in CFU/m$^3$ of air. Preliminary analysis showed that the most polluted bioaerosol was observed in cloak room for men (CM1, CM2) and production storages (PS1, PS2). The highest total number of microorganisms in air (4.5 103 CFU/m$^3$) was observed in cloak room (CM2). The number of microorganisms - from 102 to 103 CFU /m$^3$ of air was in production zone.

**Keywords:** food industry, bioareosol, airborne microorganism, fungal contaminants

Implementing a system to ensure the quality of the product described in ISO 22000:2006 and forced to have a HACCP system in the food industry [1] resulted in increased interest in monitoring the microbiological purity of the air and surfaces in the technology halls. Despite the indication of both the ISO 22000 and the code of Good Manufacturing Practice (GMP) to monitor the microbiological purity of the air in the Polish law is the lack of normative reference to the content of specific groups of microorganisms in bioaerosol [2, 3]. The problem with the content of microorganisms and especially filamentous fungi in the environment of production in the food industry is real and the lack of reference values makes, that food factories do not take preventive measures. In recent years, there have been reports on the sanitary conditions of the dairy and wine industry [4, 5], and in 2006, the plant produces packs for the food industry [3]. The above reports indicate, that the halls and usable areas are contaminated with fungi such as *Penicillium*, *Aspergillius*, *Cladosporium* and *Fusarium* [3, 6]. They influence on the contamination of food products, as well as a potential threat to human health.

The aim of this study was to evaluate the sanitary conditions of indoor air in food industry plants in Opole region.

## Materials and methods

The assessment of air quality in the food plant with both preservatives and in aseptic conditions (generated in the production machine) was conducted in the spring in the

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following areas: the main production hall (HP, HP3, HP4) and packing department (PD), clean (AC) and unclean (AU) aseptic production halls, ladys' cloak room (CL) and the two men's locker rooms (CM1, CM2), a technical storage (TS), production storages (PS1, PS2) and in the canteen (CA).

Bioaerosol analysis was carried out by Koch's sedimentation method, placing a Petri dish at a height of 1.3 m for 15 minutes [7]. Each culture was incubated at 25ºC for 48 hours - bacteria (in the BTL agar) and filamentous fungi (in Czapek BTL medium) for 7 days. Content of microorganisms in air, using the Omeliański formula, was calculated and expressed as the number of colony forming units (CFU) in 1 $m^3$ of air [8]. The results are given in [%] as the ratio of the number of bacteria and fungi in the air in the test areas of food production plant.

Subsequently we performed a preliminary qualitative analysis of isolated filamentous fungi [9, 10].

## Results

Preliminary microbiological analysis of the bioaerosol showed, that the most polluted areas in the plant were men's cloak rooms (CM, CM2) and warehouses of finished products (PS1, PS2) and the highest total number of microorganisms in the air ($4.5 \cdot 10^3$ cfu/$m^3$) was observed in men's cloak room (CM2). However, the air in the production area the total number of microorganisms (TNM) ranged from $3.49 \cdot 10^2$ cfu/$m^3$ (in HP space) to $1.34 \cdot 10^3$ cfu/$m^3$ (in HP4 space) (Fig. 1).

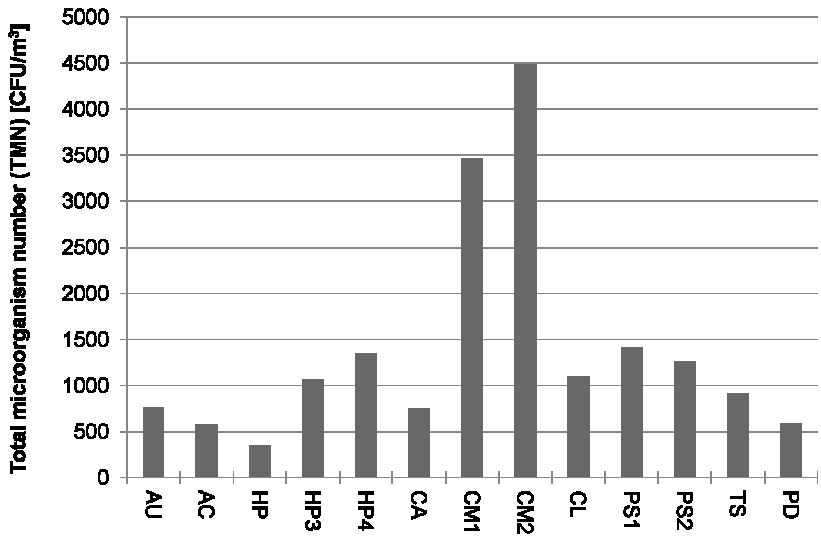


Fig. 1. The total number of microorganisms in 1 $m^3$ of air [cfu/$m^3$] in the production areas (AU, AC, HP, HP3, HP4, PD); men's cloak rooms (CM, CM2); - ladys' cloak room (CL); production storages (PS1, PS2); technical storage (TS)

The changing rooms (CM1, CM2), which were the most microbiologically contaminated, as well as the production areas (HP, AU, HP4) were dominated by bacteria and they were in 70-80% and 60-70% of the air, respectively. Only in the case of the HP3 production line and the line which prepares packaging materials (PD) filamentous fungi accounted for over 80% of the total number of microorganisms in the air (Fig. 2).

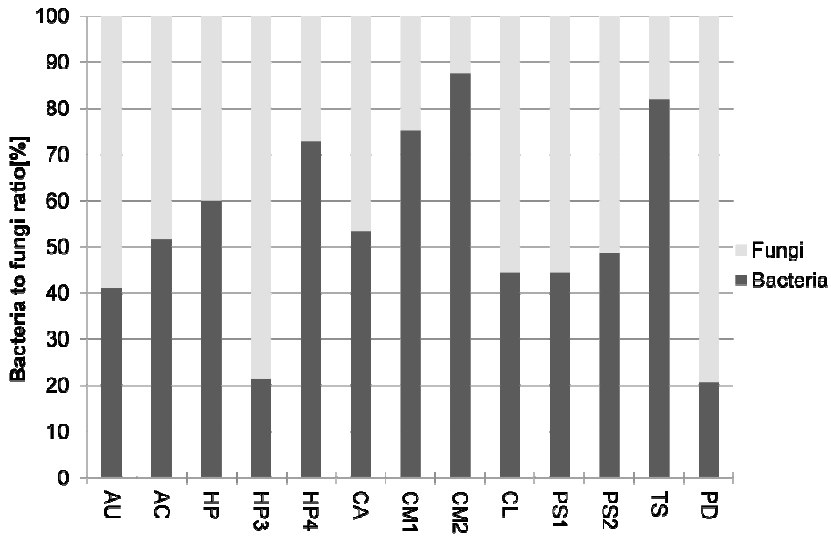


Fig. 2. Bacteria to fungi ratio in the air in a different rooms of the food production plant [%]

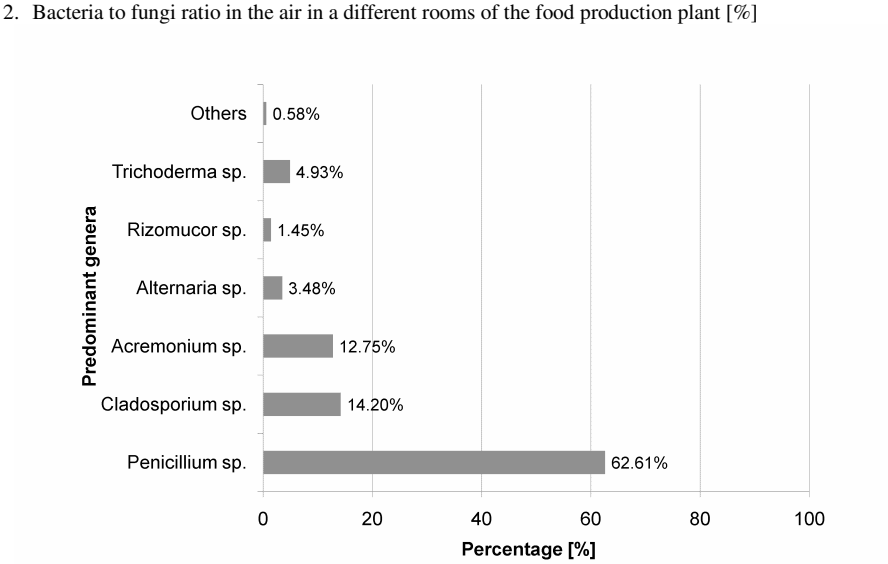


Fig. 3. Predominant genera of filamentous fungi in the air of the food production plant [%]

The greatest species diversity of filamentous fungi was found in the rooms such as men's and women's cloak rooms and production storages. Isolated on the plant area fungi were classified into genus: *Penicillium* (63%), *Cladosporium* (14%), *Acremonium* (13%), *Trichoderma* (5%), *Alternaria* (3.5%) and others (1.5%) (Fig. 3).

Many authors seeks to provide reference values for the content of microorganisms in bioaerosol but various studies, however, use different methodology which causes difficulty in their comparison [2, 11]. Also there is a lack of the specific normative values for air microbial contamination in different sectors of the food industry, with emphasis on the nature of the production and the technology used [3]. The only general description for the food industry are the recommendations proposed by Krzysztofik [12], where permissible concentration of the total number of microorganisms in 1 $m^3$ of air should not exceed $6 \cdot 10^2$ CFU, and does not allow for a growth of filamentous fungi on Sabouraund medium [12]. In the case of the analyzed plant, the parameters adopted above, the permissible level of microbial contamination satisfy only rooms HP and AC. Both study by Kręgiel [3] in a technology hall and analyzed by Dioguardieg and Franzetti [13] regional dairies in northern Italy does not satisfy this criterion [3, 13]. Therefore, it is important to analyze the risks resulting from microbial pollution in different sectors of the food industry and the establishment of individual standards including the impact of bioaerosol on the quality of the product and its possible contamination.

## Conclusions

Conducted a preliminary study showed that the most microbiologically polluted areas in the plant does not belong to the area of production but the locker rooms and warehouses. Reducing the number of microorganisms present in these areas will prevent the spread of them to the production area. The lack of appropriate reference values and the poor number of studies on microbiological contamination in food industry causes the difficulties in comparing the results.

The next stage of research will be screening of antimicrobial substances. The research will be conducted on strains isolated from air and surface of a plant. After finding the essential oil and its concentration will be carried out a study in one of the social rooms.

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## ANALIZA MIKROBIOLOGICZNA BIOAREOZOLU W ZAKŁADACH PRZEMYSŁU SPOŻYWCZEGO

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**Abstrakt:** Obecność bakterii i grzybów strzępkowych w zakładach przemysłu spożywczego wpływa zarówno na jakość, jak i na stabilność produktów spożywczych. Niebezpieczne jest zwłaszcza zanieczyszczenie grzybami strzępkowymi ze względu na produkowane przez te drobnoustroje alergeny i mikotoksyny. Celem przeprowadzonych badań była ocena skażenia mikrobiologicznego powietrza oraz wskazanie dominujących grup mikroorganizmów w poszczególnych pomieszczeniach zakładów przemysłu spożywczego. Analiza bioareolozu była prowadzona metodą sedymentacyjną Kocha - umieszczone na wysokości 1,3 m szalki Petriego (90 mm) eksponowano przez 15 min. Analiza czystości mikrobiologicznej powietrza była prowadzona w różnych pomieszczeniach zakładów produkcji spożywczej: hali produkcyjnej (HP, HP3, HP4), hali produkcji aseptycznej (AC, AU), hali przygotowania opakowań jednostkowych (PD), szatniach (CL, CM, CM2), magazynach produkcyjnych (PS1, PS2), magazynie technicznym (TS) i stołówce (CA). Wyniki zostały przedstawione w jtk/$m^3$ powietrza. Wstępne badania wskazały, że najbardziej zanieczyszczone mikrobiologicznie były szatnie męskie (CM1, CM2) i magazyny produkcyjne (PS1, PS2). Najwyższą ogólną liczbę mikroorganizmów w powietrzu (4,55 $10^3$ jtk/$m^3$) odnotowano w jednej z szatni (CM2). Ogólna liczebność mikroorganizmów w powietrzu strefy produkcji wahała się od $10^2$ do $10^3$ jtk/$m^3$.

**Słowa kluczowe:** przemysł spożywczy, bioaerozol, mikroflora powietrza, zanieczyszczenia grzybami