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MICROBIAL AIR CONTAMINATION ON THE MARKETPLACES IN KRAKOW

MIKROBIOLOGICZNE ZANIECZYSZCZENIE POWIETRZA NA PLACACH TARGOWYCH W KRAKOWIE

Abstract: Microbiological air research was conducted on five different marketplaces in Krakow and on the Blonia meadows in different seasons. The air was sampled by using the collision method with a microbiological air-sampler MAS-100 (Merck). Abundance of bacteria ranged from 42 to 2300 CFU/m³. Fungi were seldom present and ranged from 30 to 3460 CFU/m³. Actinomycetes were most uncommon and their quantities ranged from 0 to 140 CFU/m³, but quantities that ranged over 100 CFU/m³ also caused heavy atmospheric air pollution. Research proved a tight correlation between microorganisms' occurrence and seasons. During summer bacteria appeared in larger numbers whereas fungi and actinomycetes had larger quantities during springtime.

Keywords: air microflora, marketplace, Krakow, bacteria, fungi, actinomycetes

Marketplaces that have existed for several hundred years in Krakow etched permanently into its landscape and history. They are places where not only all kinds of food, crops or flowers are sold but also where normal daily life goes. Many people consider food sold on such marketplaces directly by farmers to be fresh, healthy and nutritious. Quality of products sold on marketplaces is often influenced by their surroundings. Marketplaces are located in the city centres neighbouring crowded streets with plenty of cars and people [1].

Such locations may have negative impact on microbiological quality of the products, due to high concentration of air dust and bioaerosols containing various size dust particles that can transmit microorganisms. Bioaerosols may be of natural origin: plants, soil, open water reservoirs, or anthropogenic, such as waste, sewage, agriculture, animal husbandry, etc. [2–6].

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Currently literature lacks information about atmospheric air quality on marketplaces. The only available data concern air quality in supermarkets [7]. On the other hand, with respect to external environment, microbial quality of food sold on the streets of Sao Paulo in Brazil [8], or on Thailand marketplaces [9] was analysed, whereas microbial air quality was ignored.

The aim of the present research was to carry out microbiological analyses of air regarding microbial abundance (bacteria, actinomycetes, mould fungi) in crowded places where microbial bioaerosol can adversely affect food quality.

Material and methods

Air sampling was performed on five marketplaces at fixed locations and the control site was located at the Blonia meadows. The sampling sites were located in the centers of analysed objects. The air was sampled in 4 seasons (spring: 27th May 2009, summer: 28th July 2009, autumn: 26th October 2009, winter: 18th January 2010), before noon.

Air sampling was performed by MAS-100 (Merck) air sampler, at a height of 1.3 m above the ground – according to Polish Standard PN-89/Z-04008/08 [10]. Incubation conditions and applied media (according to Polish Standard: PN-89/Z-04111, sheets 02 and 03) [11, 12] are presented in the Table 1.

Table 1

Microbial culture conditions

Microorganisms	Temperature [°C]	Time of incubation [h]	Medium
Total no. of bacteria	37	24	Nutrient agar
Fungi	28	120	Wort agar
Actinomycetes	28	168	Gauss medium

Based on the guidelines of the above – mentioned standards (Tables 2 and 3) microbial air pollution was evaluated.

Table 2

Evaluation of bacterial air contamination [CFU per 1 m³]

Total no. of bacteria	No. of actinomyces	Air pollution degree
< 1000	10	No pollution
1000–3000	10–100	Average pollution
> 3000	> 100	Heavy pollution

Table 3

Evaluation of fungal air contamination [CFU per 1 m³]

Total no. of fungi per 1 m ³ of air	Air pollution degree
< 3000	No pollution
3000–5000	Average air pollution, especially in late-spring and early-autumn
5000–10000	Pollution that may adversely affect human environment
> 10000	Pollution that threaten human environment

Results and discussion

The following percentage of the analysed microorganisms on the marketplaces was indicated by the quantitative study:

- bacteria – 61.5 %;
- fungi – 35.5 %;
- actinomycetes – 3 %.

Considering the average number on all analysed marketplaces in all seasons, bacteria were most abundant in summer (1238 CFU/m³), slightly less abundant in autumn (939 CFU/m³) and in spring (936 CFU/m³); the smallest average number of bacteria occurred in winter (447 CFU/m³). In the research carried out in Torun Donderski et al [13] found seasonal variations in bacterial abundance; abundances found by them were significantly lower, but it resulted from the nature of the sampling sites.

Comparing with the control site at Blonia meadows bacterial numbers were higher in all analysed marketplaces, from nearly 3 times greater abundance in Plac Nowowiejski to nearly 8 times greater in Plac Imbramowski. Bacteria (Fig. 1) were the most abundant in Plac Imbramowski, particularly in summer (2130 CFU/m³) and autumn (2305 CFU/m³). High bacterial abundances on this marketplace result most probably from the close neighbourhood of a crowded street, large number of buyers as well as from the lack of green spaces in the neighbourhood that could retain dust and bacteria. Bacteria, on the other hand, were least numerous at Blonia meadows in autumn (15 CFU/m³). Such high differences in bacterial abundance in the same season are mostly related to the sampling sites location. Similar results were obtained by Giorgio et al [14] in Marseille. Average bacterial abundance on all marketplaces was nearly 5 times higher than in the control site (890 in comparison to 179 CFU/m³).

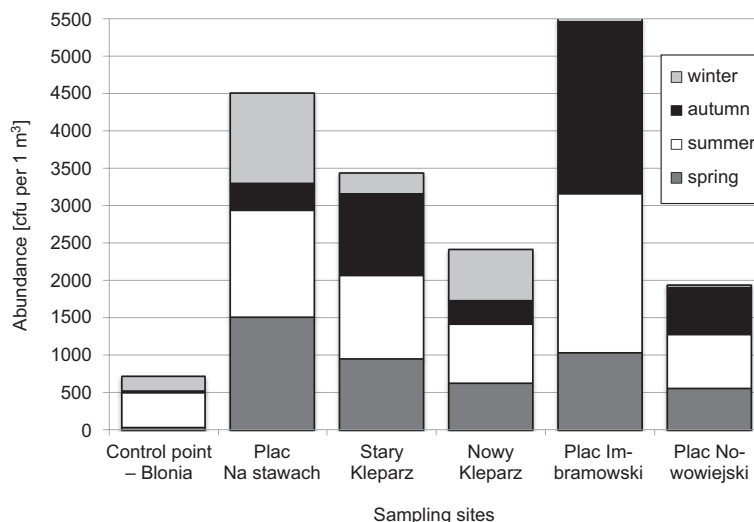


Fig. 1. The number of bacteria on marketplaces in different seasons

Bacterial air pollution was average according to Polish Standards [11] in 3 out of 5 analysed marketplaces (Plac na Stawach, Plac Imbramowski, Stary Kleparz, including 2 marketplaces in 3 seasons).

Large number of fungal spores (Fig. 2) occurred mostly in spring and summer, whereas fungi were less abundant in autumn. Stary Kleparz was the most polluted place concerning fungal abundance – 3460 CFU/m³ were found there in spring. This result could be affected by numerous stalls with flowers and field vegetables such as potatoes or beets. Fungal spores are released from their surface and from the ground. High numbers of fungi were found at Blonia meadows in spring and in summer – higher than in the majority of the analysed marketplaces; such high abundance of fungi might have resulted from lush vegetation that could have promoted fungal development. Therefore, the average number of fungi on the marketplaces (513 CFU/m³) was lower than in the control site (652 CFU/m³). In the study of seasonal variations in fungal number in Krakow Medrela-Kuder [15] indicated their highest incidence in summer, half that number in spring and in autumn, and the lowest number in winter. On Nowy Kleparz, Plac Imbramowski and Plac Nowowiejski discovered number of fungi was similar to the studies presented by Medrela-Kuder [15]. Bacteria outnumbered fungi in the analysed marketplaces almost in all cases except summer measurements carried out in Stary Kleparz and in Plac Nowowiejski.

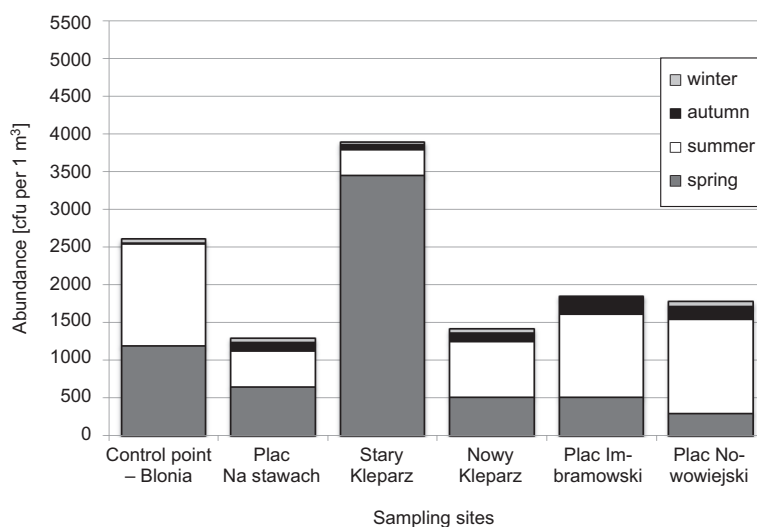


Fig. 2. The number of fungi on marketplaces in different seasons

According to Polish Standards [12] results of spring measurements revealed average mould fungi pollution of air only in Stary Kleparz.

Actinomycetes are widespread in the environment, especially in soil, on plant surface, or animals [16]. They were the least numerous among all studied microorganisms (Fig. 3), but their presence was found on each sampling site.

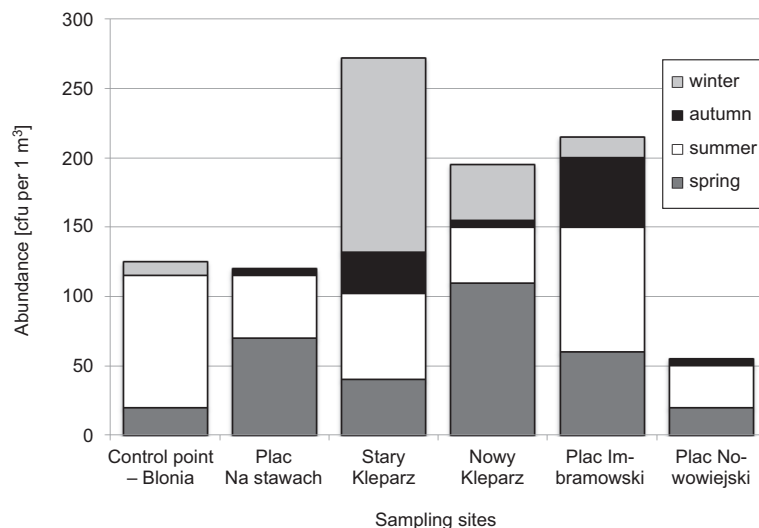


Fig. 3. The number of actinomycetes on marketplaces in different seasons

Significant differences can be observed in abundance of actinomycetes – *eg* they occurred profusely on Stary Kleparz in winter (140 CFU/m³), but they were absent on Plac Nowowiejski. Actinomycetes occurrence was frequent both in spring (Nowy Kleparz, Plac Na Stawach, Plac Imbramowski), and in summer (Plac Imbramowski, Błonia, Stary Kleparz). Their abundance was nearly twice lower on Plac Nowowiejski than on the control site, whereas opposite results were obtained on Stary Kleparz, where number of these microorganisms was over twice higher in relation to the control site. According to Marcinowska [16] actinomycetes abundance increases from spring to autumn and their highest numbers are detected in summer. This is consistent with the results obtained on Plac Imbramowski and Nowowiejski. Soil nearby the marketplaces or in flower pots or on vegetables can act as a source of actinomycetes.

According to Polish Standards [11] average actinomycetal air pollution was observed on all marketplaces as well as on the control site in spring and in summer; whereas heavy air pollution was observed on Nowy Kleparz in spring and on Stary Kleparz in winter.

Conclusions

1. On the studied marketplaces bacteria were the most numerous group of all microorganisms and mould fungi belonged to the second numerous group.
2. Quantity of the studied microorganisms showed seasonal variations. Bacteria were the most numerous in summer, whereas fungi and actinomycetes predominated in spring. In turn, minimum numbers of bacteria and fungi occurred in winter and minimum numbers of actinomycetes was detected in autumn.

3. Abnormally high number of actinomycetes was detected on Stary Kleparz (in winter) and on Nowy Kleparz (in spring).
4. Average air pollution occurred:
 - a. due to bacterial abundance: on Plac Na Stawach and on Plac Imbramowski in 3 seasons, on Stary Kleparz in 2 seasons,
 - b. due to fungal abundance: on Stary Kleparz in spring,
 - c. due to actinomycetal abundance: on all marketplaces in spring and in summer, on Stary Kleparz and on Plac Imbramowski in autumn, and on Stary and Nowy Kleparz and on Plac Imbramowski in winter.
5. The analysed marketplaces may be arranged in the following order of increasing total number of microorganisms: Plac Nowowiejski, Nowy Kleparz, Plac Na Stawach, Plac Imbramowski, Stary Kleparz.

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**MIKROBIOLOGICZNE ZANIECZYSZCZENIE POWIETRZA
NA PLACACH TARGOWYCH W KRAKOWIE**

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Abstrakt: Badania mikrobiologiczne powietrza przeprowadzone zostały na pięciu placach targowych Krakowa i na miejskim terenie zieleni (Błoniach) – jako kontroli w różnych porach roku. Próbkę powietrza pobierane były metodą zderzeniową za pomocą aspiratora MAS-100 firmy Merck. Liczebność bakterii w powietrzu badanych placów targowych wahała się od 42 do 2300 jtk/m³, natomiast grzybów pleśniowych od 30 do 3460 jtk/m³. Promieniowce występowały najrzadziej w ilościach od 0 do 140 jtk/m³, lecz stwierdzone liczebności wynoszące ponad 100 jtk/m³ również wskazywały na silne zanieczyszczenie powietrza atmosferycznego. Badania wykazały korelację występowania mikroorganizmów z porą roku. W okresie letnim maksimum swojego występowania miały bakterie, natomiast grzyby i promieniowce w okresie wiosennym.

Słowa kluczowe: mikroflora powietrza, plac targowy, Kraków, bakterie, grzyby, promieniowce