ISSN: 1220-3173; E-ISSN: 2457-7618

MICROBIOLOGICAL AIR POLLUTION IN AREAS WHERE PIGEON COLONIES LIVE, IN TIMISOARA, ROMANIA

POLUAREA MICROBIOLOGICĂ A AERULUI ÎN ZONELE UNDE TRĂIESC COLONII DE PORUMBEI, ÎN TIMIȘOARA, ROMÂNIA

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ABSTRACT | REZUMAT

Urban pigeons (*Columba livia* var. *domestica*) are very well adapted to life in big cities, being organized in larger or smaller colonies, depending on the area. They receive support from bird lovers who provide them with food and water. The areas where these pigeon colonies live are frequented by children and elderly people, which increase the risk of exposure to different microorganisms. Pigeons can be an important source of pathogenic microorganisms, with the possibility of transmission to humans, being in relatively close contact with humans. Through the aerosolization of pigeon droppings and secretions, microorganisms with zoonotic potential can be a danger to human health. The present study was carried out to estimate the concentration of airborne bacteria and fungi in the air of the perimeters where large pigeon colonies live, in the city of Timisoara. The study of microbial air pollution in spaces populated by urban pigeons was carried out in two areas of the city were live big colony. Air samples were collected by the aspiration method from the perimeters of the pigeon colonies and at a distance of 100 meters from them. The monitored microbiological indicators were the total number of aerobic bacteria, the number of coliforms, staphylococci and fungi in a cubic meter of air. The results showed that in the places colonized by pigeons, the air had a very high load of the total number of germs, coliform bacteria, staphylococci and the number of microscopic fungi, which means an intense microbial pollution. In the areas located 100 meters away from the pigeon colonies, the microbial load of the air was significantly lower, but sometimes high values of the number of coliforms and staphylococci were found. The attending of areas with high load of airborne bacteria, by the people with low immunity, presents risk for illness; therefore, better health information of the population should be provided.

Keywords: pigeon, microbiological pollution, total aerobic bacteria, Coliforms, Staphylococci, Fungi, Health risk

Porumbei urbani (*Columba livia* var. *domestica*), sunt bine adaptați la viața din marile orașe, fiind organizați în colonii, mai mari sau mai mici, dependent de areal. Aceștia primesc suport de la iubitorii de păsări, care le asigură mâncare și apă. Zonele în care trăiesc aceste colonii de porumbei sunt frecventate de copii și de oamenii în vârstă, ceea ce dezvoltă riscul expunerii la diverse microorganisme. Porumbeii por fi o sursă importantă de microorganisme patogene, cu posibilitate de transmitere la om, fiind în contact relativ apropiat de oameni. Prin aerosolizarea dejecțiilor și a secrețiilor porumbeilor, microorganismele cu potențial zoonotic pot fi un pericol pentru sănătatea oamenilor. Studiul prezent a urmărit să evalueze concentrația de bacterii și fungi din aerul perimetrelor unde trăiesc colonii mari de porumbei, în orașul Timișoara. Studiul poluării microbiene a aerului în spațiile populate de porumbei urbani s-a realizat în două zone ale orașului unde există colonii mari de porumbei. S-au recoltat probe de aer prin metoda aspirației din perimetrele coloniilor de porumbei și la distanta de 100 de metri de acestea. Indicatorii microbiologici urmăriți au fost numărul total de bacterii aerobe, numărul de coliformi, de stafilococi și de fungi, dintr-un metru cub de aer. Probele de aer au fost recoltate din două în două săptămâni, din februarie până în iunie. Rezultatele au evidențiat că în locurile colonizate de porumbei aerul a avut o încărcătură foarte mare a numărului total de germeni, de bacterii coliforme, de stafilococi și a numărului de ciuperci microscopice, ceea ce semnifică o poluare microbiană intensă. In zonele aflate la 100 de metri distanță de coloniile de porumbei încărcătura microbiana a aerului a fost semnificativ mai redusă, dar uneori s-au constatat valori mari a numărului de coliformi și de stafilococi. Frecventarea zonelor cu o încărcătură microbiană a aerului crescută, datorită densităților mari de porumbei, de către persoanele cu imunitate scăzută, mai ales de copii și de bătrâni, reprezintă risc de îmbolnăvire; de aceea ar trebui o mai bună informare sanitară a populației.

Cuvinte cheie: porumbei, poluare microbiologică a aerului, bacterii aerobe totale, coliformi, stafilococi, fungi, risc pentru sănătate

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It is well known that in the big cities of each country, pigeons (*Columba livia* var. *domestica*) live in large numbers, organized in larger or smaller colonies, depending on the area (12). Pigeons have been well adapted to architectural structures in cities, making nests in the roofs of houses and blocks of flats and frequently visiting window sills. Through their activity, pigeons cause a number of problems. Due to the chemical and microbiological composition of the faeces, their droppings damage buildings and other architectural structures (1, 8, 21, 28).

Moreover, pigeons can be an important source of pathogenic microorganisms, with the possibility of transmission to humans, being in relatively close contact with them. People have frequent interactions with pigeons, more or less voluntarily. In every area full of pigeons, such as parks, promenades, playgrounds, there are lovers of these birds, who feed them either with grain or food scraps from their own households, or even handle these birds, especially sick pigeons (13, 30).

Although the danger to human health has not yet been sufficiently well assessed, clinicians draw attention to the risk of contracting a number of diseases, due to the fact that the droppings and sometimes the dead bodies of wild pigeons are found in the yards of houses, the spaces around the blocks, in playgrounds, in parks, where the population density is high. The faecal bacterial flora of pigeons can be an important source of infectious diseases in humans. In the city of Barcelona, C*ampylobacter jejuni, Campylobacter coli, Salmonella* spp., *Yersinia* spp. and *Listeria* spp. were identified in over 400 cloacal samples from pigeons (4). In Japan, from samples collected from the digestive tract of urban pigeons, the presence of *Cl. welchii* (*Cl. perfringens*) and *S. typhimurium* were isolated, some strains being enterotoxigenic (10).

Numerous studies have shown that urban pigeons are carriers of *Chlamydophila psittaci, Campylobacter jejuni* and *Campylobacter coli* (5, 9, 14, 20).

Feral pigeons (*Columba livia domestica*), which thrive in most European cities, are commonly infected with the zoonotic bacterium *Chlamydophila psittaci*, the agent of psittacosis (also known as ornithosis in humans).

A series of surveys carried out in recent years across Europe have detected high seropositivity and high infection rates in wild pigeon populations. Inhalation of dust contaminated with *C. psittaci,* direct contact with pigeons through handling them, and, to a lesser extent, feeding pigeons were identified as hazardous exposures in more than half of human cases, while loose or transient contacts with wild pigeons were identified and mentioned in approximately 40% of cases (18). Pigeons that live around cities and can come into contact with manure from animal farms could become carriers of verocytotoxin - producing *Escherichia coli*, strains that live in the gastrointestinal tract of cattle and sheep (7).

Epidemiological studies and reports are conducted to evidence the transmission of diseases from pigeons to humans. From the research carried out by *Haag-Wackernagel* and *Moch* (2004) it appears that feral pigeons were found to be carriers of 60 of the microorganisms pathogenic to humans, but only a few of these have been transmitted to humans. From all of these, five pathogenic species were viruses, nine were bacteria, four were fungi, and one was a protozoan. There is only one paper demonstrating transmission of *Salmonella enterica* serotype *Kiambu* to humans from feral pigeons, but no transmission of *Campylobacter* spp. has been reported. The pathogens most commonly transmitted by feral pigeons continue to be *Chlamydophila psittaci* and *Cryptococcus neoformans* (13). The implications of pigeons in the transmission of pathogenic viruses for humans and animals have been studied by numerous researchers. The pigeons proved to be seropositive for the St. Louis encephalitis virus, equine encephalomyelitis virus, rubella virus, and West Nile virus (11, 15, 16, 24).

Studies conclude that urban pigeons present little risk to people with good immunity. But people with deficient immunity, due to age or some diseases, are exposed to almost 1000 times greater risk, compared with healthy people, of being contaminated with microorganisms from pigeons, including *E.coli, Chlamydia, Cryptococcus, Chlamydophila, Histoplasma, Salmonella* and various viruses, if they come into contact, directly or indirectly, through aerosols or with their droppings (22, 29).

Currently, researches are more oriented towards understanding and explaining the mechanisms of antibiotic resistance, a phenomenon that is increasingly reported, as well as finding and testing numerous substances, some synthetic and numerous natural extracts that promise good antibacterial action and are recommended for replacing antibiotics or antiseptic and disinfectant solutions. In this context, the research aimed to identifying the sources of bacterial pollution of the environment and those that can ensure the improvement of the sanitary culture of the population has been reduced, which would be beneficial in the context in which the cult of epidemics is developing (3, 23, 25).

The present study was carried out to estimate the concentration of airborne bacteria and fungi in the air of the perimeters where large pigeon colonies live, in Timisoara city, and where many people, especially the elderly and children, who may have low immunity, can come, directly or indirectly, in contact with the pigeons.

MATERIALS AND METHODS

The study of air pollution in the spaces populated by urban pigeons was carried out in two areas of the city of Timișoara (Fig. 1. A, B), namely: in the Lipova area (45° 46'32.8"N 21°14'23.7"E), called area A, and in the centre of the city, near the building of Timișoara Opera House (45°45'13.4"N 21°13'32.7"E), considered area B. These two locations were chosen considering the high density of pigeons in these areas and the activity of people, the use as play areas for children, promenade zone, and for relaxation activity by feeding the pigeons (Fig. 2. A, B).

Microbiological air samples were taken twice a week, from February to June, 2022, in conditions of atmospheric stability, in the absence of precipitation and strong wind.

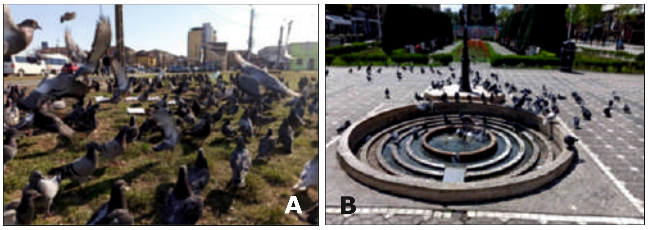

Fig. 1. Sampling points (area A and B), where the air microbiological load was evaluated

Fig. 2. Aspects of the pigeon colonies and human activity in study areas, in the city of Timișoara

In order to monitor the microbial air pollution in the two areas, the microbiological examination of the air was carried out, which monitors specific indicators such as the aerobic bacteria number (ABN), the coliforms, the staphylococci, and the total number of fungi. Air samples were taken, at each point, by aspiration method with the device PBI Air Sampler SAS Super 100 (International PBI SpA Milano, Italy). The device was set to aspirate at an air volume of 5 L per min. The air sampling was realized at a height of 1.3–1.5 m above ground level to signify the breathing zone. Petri dishes with nutrient agar were used to determine the ABN, Levine for coliforms, Chapman for staphylococci and Sabouraud medium for the total fungal count (TFC). After sampling, the plates were incubated 24 h at 37°C for ABN, coliforms, and staphylococci and at 25°C for TFC. Plates were examined by counting the colonies developed on the surface of each culture medium, taking into consideration the cultural characteristics.

For aerobic bacteria numbers, all colonies grown on the plate were counted. For coliforms, only the characteristic *E. coli* colonies were counted, smooth, round colonies with a blue-green metallic colour. On the Chapman medium, were also counted characteristic colonies, smooth, round and yellow colonies, which discoloured the culture medium in yellow. On the Sabouraud medium, all colonies were counted, both the fluffy, mycelial ones and the creamy, yeasty ones. The number of colonies identified on each plate was then equated, in real values, using the standardized tables provided by the manufacturer of the sampling device. In addition, in order to have comparison data, each time, in both areas, the microbiological indicators of the air were also determined at a distance of approximately 100 m from the area populated by pigeons. The data were centralized, statistically processed, and discussed. For each microbiological indicator was calculated the average ± SD. To analyse the differences obtained between different sampling points was used one-way ANOVA test followed by Tukey HSD (Statistical Package for the Social Sciences-SPSS). The level of significance was considered at $p < 0.05$.

Considering that in our country there are no norms stipulated for the microbial load of the air in different spaces and locations, not even in animal farms or in schools, in order to establish the degree of pollution, the Exterior Air Quality Standards were taken into account, used by the Polish-European Agency for Environmental Protection, PN-89/Z-04111/02 and PN-89/Z-04111/03, summarized in Table 1 (22).

RESULTS AND DISCUSSIONS

The average values of the air microbial indicators, determined between February and June, in the space where the pigeon colony from area A lives and at a distance of approximately 100 m from the colony, are shown in Table 2. From this study, it was found that in the perimeter occupied by the pigeon colony in area A, all microbiological air indicators monitored had high values, exceeding the recommended values (Table 1) (22).

The total aerobic bacteria number (ABN) had an ave-

Table 1

Microbiological air requirements (22)

Pollution level	Aerobic mesophilic bacteria (cfu/m3)	Staphylococci (cfu/m3)	Coliforms (cfu/m3)	**Fungi** (cfu/m3)
Not polluted	≤ 1000	0	0	3000-5000
Moderately polluted	1000-3000	≤ 25	≤ 25	5000-10000
Highly polluted	>3000	> 25	> 25	> 10000

Table 2

Average values (X±SD) of air microbial indicators in area A

Air microbial indicator	**In the area of urban pigeon colony**	**At 100 m distance from the urban pigeon colony**
Aerobic bacteria number (ABN) - cfu / m3	6458.7 ± 1492.1	760.4 ± 89.4
Coliforms - cfu / m3	166.5 ± 84.5	6.6 ± 20.9
Staphylococcus - cfu / m3	446.2 ± 137.1	19.8 ± 31.9
Total number of fungi (TNF) - cfu / m3	5622.3 ± 1453.4	507.1 ± 254.2

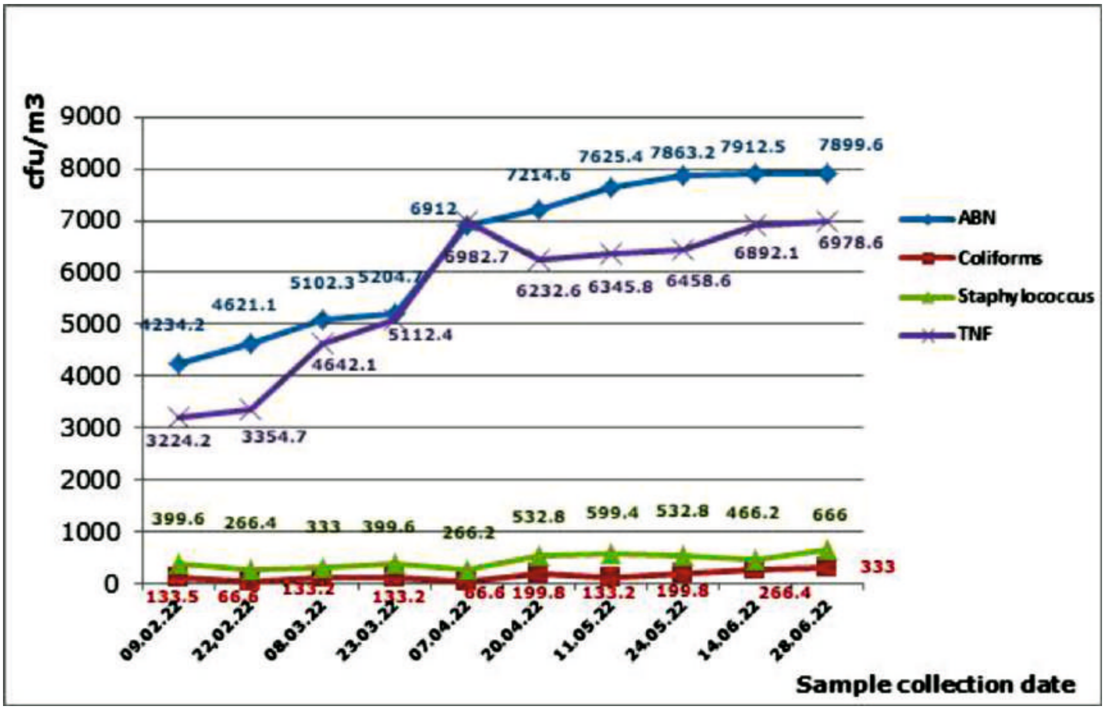

Fig. 3. Microbial load of the air in the perimeter where lives the colony of pigeons, area A

rage value of 6458.9±1492.1 cfu/m³, exceeding six times the recommended value for unpolluted air of ≤ 1000 cfu/m³, falling into the category of highly polluted air (>3000 cfu/m³). The average number of coliform bacteria was on average 166.5±84.5 cfu/m³, exceedingly approximately twice the value recommended for moderately polluted air, also falling into the category of intensely polluted air (> 25 cfu/m³). In the case of unpolluted air, the presence of coliform bacteria /m³ is not allowed. The same aspect, of classification in the category of intensely polluted air, was also found in the case of staphylococci, their average number, during the study period, being 446.2 ± 137,1 cfu/m³. The average number of microscopic fungi (fungi and yeasts) in the air of the perimeter where the pigeon colony in area A lives, was 5622.3±1453.4 cfu/m³. From the point of view of this indicator, it can be classified in the category of moderately polluted air (5000-10000 cfu/m³). The values of the microbiological indicators of the air determined in area A, where pigeons live, are shown in Fig. 3. The air in this pe-

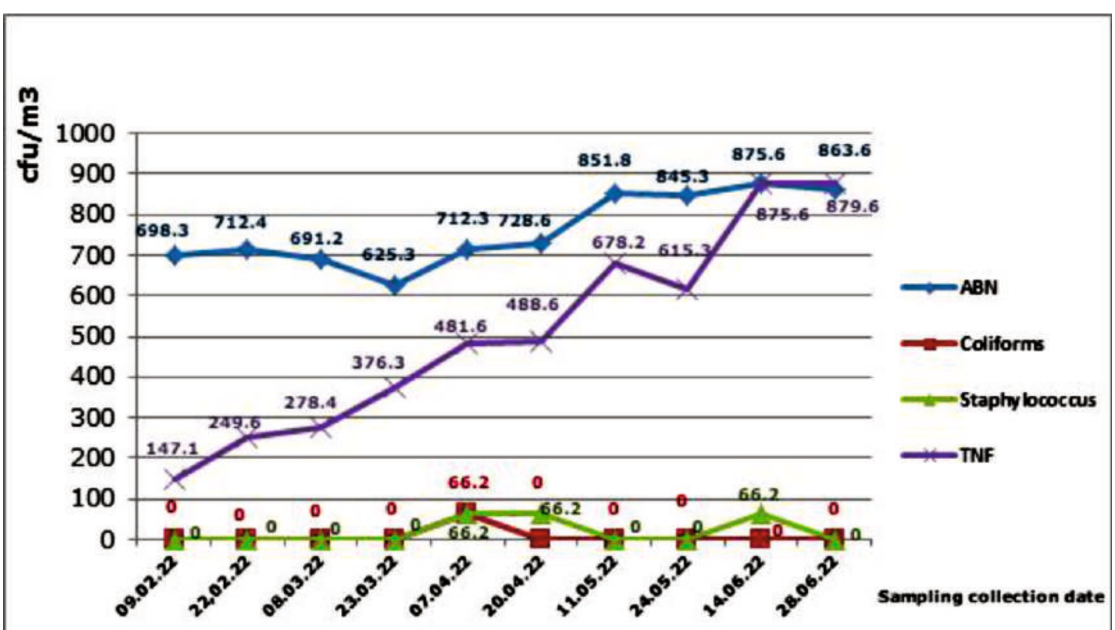

Fig. 4. Air microbial load at 100 m distance from the pigeon colony, area A

Table 3

Average values (X±SD) of air microbial indicators in area B

Air microbial indicator	In the urban pigeon colony	At 100 m distance from the urban pigeon colony
Aerobic bacteria number (ABN) - cfu / m3	807.6 ± 87.6	407.6 ± 52.2
Coliforms - cfu / m3	126.5 ± 105.1	19.8 ± 31.9
Staphylococcus - cfu / m3	299.5 ± 90.5	66.4 ± 66.6
Total number of fungi (TNF) - cfu / m3	2382.3 ± 540.5	536.7 ± 170.2

rimeter had increased values for all the microbial indicators monitored during the entire period of the study. Total aerobic bacteria number per cubic meter of air had increasing values from 4234.2 cfu/m³ and respectively 4621.1 cfu/m³, in February, to 7912.5 cfu/m³ and respectively 7899.6 cfu/m³. Also, the total number of coliforms increased from 66.6 cfu/m³, respectively 133.5 cfu /m³, in February to 266.4 cfu/m³ and 333 cfu/m³, and the number of staphylococci reached values of 666 cfu/ m³, in June compared to 266.4 cfu/m³ in February. It is noted that the total number of fungi had high values during the entire period of the determinations, increasing from 3224.2 cfu/m³, in February, to 6978.6 cfu/m³, in June, but even so, this indicator falls on the moderate polluted air. Instead, the values of the air quality indicators in the area of 100 meters away from the perimeter where the pigeons were active, were much lower (Table 2).

The average value of ABN was 760.4±89.4 cfu/m³, coliform bacteria had an average value of 6.6±20.9 cfu/ m3, staphylococci were, on average, 19.8±31.9 cfu/m³, and microscopic fungi (fungi and yeasts) had the average value of 507.1± 254.2 cfu/m³. During the entire period of the study, the air in this area was close to the quality of unpolluted air, even if the number of coliforms and staphylococci, in some of the determinations carried out, showed a slight exceeding of the recommended values (Fig. 4). The ABN was 698.3 cfu/m³ and 712.4 cfu/m³ in February and 875.6 cfu/m³ respectively 863.6 cfu/m³ in June. The air at the point of 100 m distance from the urban pigeon colony, area A, had a very significant lower value of total aerobic number (t-value is 12.0553 and the p-value is < 0.00001) comparatively with that found in the pigeon colony. The number of coliforms in this air recollection point was equal to 0 cfu/m³ during the entire period of the study, with a small exception, in April, when in one of the determinations was 66.2 cfu/m³. Compared to the values obtained in the pigeon colony, the number of coliforms in a cubic meter of air were significantly lower (the t-value is 5.80735, the p-value is < 0.00001), as well as the number of staphylococci, which had value of 66.2 cfu/m3, in April and at one determination in June, but, as a whole, the values of this indicator were significantly lower compared to those obtained in the pigeon colony (the t-value is 9.5794, the p-value is <0.00001). The number of fungi in the air samples from the sampling point located 100 m from the pigeon colony, in the A area had values of 147.1 cfu/m³ and respectively 249.6 cfu/ m³, in February and 879.6 cfu/m³, significantly lower than in the pigeon colony (the t-value is 10.96329, the p-value is < 0.00001). The result is significant at $p < 0.05$.

The average values of the air microbial indicators monitored in the perimeter occupied by the pigeon colony in area B, and in the space on approximately 100 meters away from it, are presented in Table 3. In the perimeter occupied by the pigeon colony in the B area, the air quality, during the study period, can fall into the category of

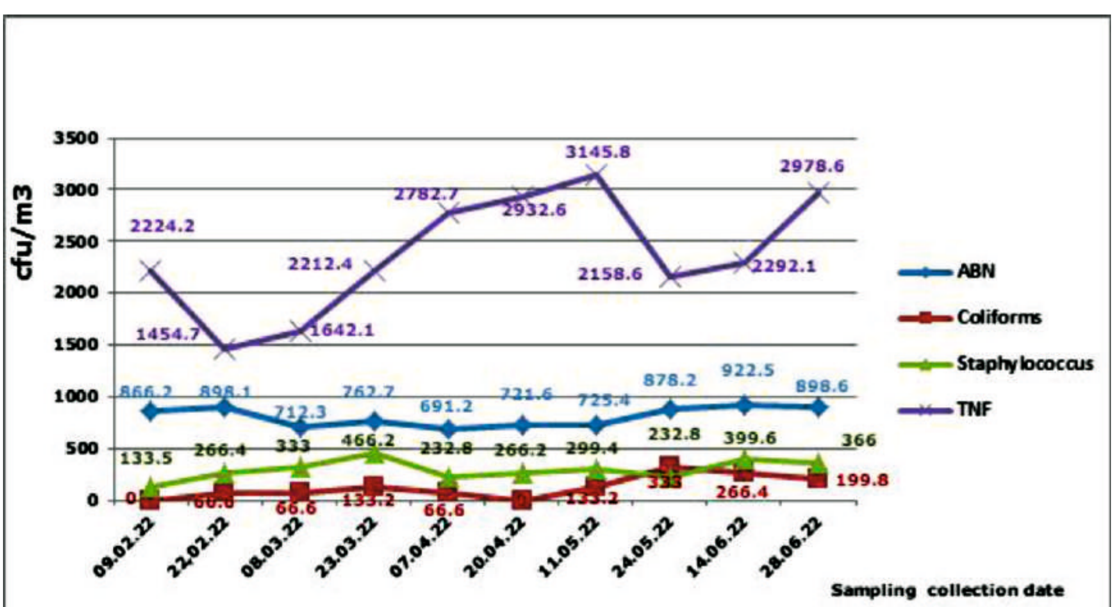

Fig. 5. Air microbial load in urban pigeon colony, area B

intensely polluted air, even if the values for ABN and the total number of fungi in one m^3 of air had low values and they fell within the recommended values for unpolluted air, according to those recommended (≤ 1000 cfu/m^3, for ABN and respectively between 3000-5000 cfu/m^3, for microscopic fungi) (22). The average value of ABN in the air during this, was 807.6±87.6 cfu/m^3, and the average number of microscopic fungi was 2382.3±540.5 cfu/m^3.

In contrast, on this perimeter, the average number of coliforms was 126.5±105.1cfu/m^3, approximately five times exceeding the recommended value for moderately polluted air (≤25 cfu/m^3). A similar aspect was also found in the case of staphylococci, which during the determination period, had an average value of 299.5±90.5 cfu/m^3, exceeding by approximately 12 times the value recommended for moderately polluted air, of ≤ 25 cfu/m^3.

The values of the microbiological indicators of the air in area B are shown in Fig. 5. It was found that, during the study period, the air in the perimeter where the pigeon colony lives, in area B, had increased values for two of the most important microbial indicators, the number of coliforms, which was 133.2 cfu/m^3 in March and 333 cfu/ m^3 in June, and staphylococci, which had values of 466.2 cfu/m^3 in March and 399.6 cfu/m^3 in June. The results regarding the microbial load of the air approx. 100 meters from the perimeter occupied by the pigeon colony, area B, reveal the fact that during the period of the determinations, had much lower values compared to those in the perimeter occupied by pigeons. These values would allow the classification of unpolluted air, if only the ABN and TNF in one air cube would be considered. Thus, the aerobic bacteria number had average values, during the determination period, of 407.6± 52.2 cfu/m^3, and the number of microscopic fungi was, 536.7±170.2 cfu/m^3. Instead, the number of coliform bacteria was, on average, 19.8±31.9 cfu/m^3, and the number of staphylococci had an average value of 66.4±66.6 cfu/m^3, exceeding the recommended values for these indicators (Table 1) (22).

Figure 6 shows the values of the air microbiological indicators, during the study period, in the perimeter located at 100 meters from the pigeon colony, area B.

The ABN had values of 469.3 cfu/m^3 in March and 460.6 cfu/m^3 in June. The total number of fungi was 247.1 cfu/m^3 in February and 779.6 cfu/m^3 in June. The number of coliforms was 66.2 cfu/m^3 in three of the determinations made, in February, March and April, and the number of staphylococci fluctuated from 66.2 cfu/m^3 in February to 199.8 cfu/m^3 in June. All the monitored indicators of the air in the area at approximately 100 meters from the pigeon colony, area B, had significantly reduced values, throughout the monitored period, compared to the values obtained in the area of the pigeon colony. For ABN, the t-value is 11.9158 and the p-value is < 0.00001, for the number of coliforms the t-value is 2.92584 and the p-value is .004513 (the result is significant at $p < .05$.). Also, for staphylococci the t-value is 6.85111 and the p-value is <.00001, and for total number of fungi the t-value is 9.81411, the p-value is < 0.00001. Even so, due to the fact that the number of coliform bacteria and staphylococci exceeds the recommended values (Table 1), the air cannot be classified as unpolluted air.

The values of the air microbiological indicators obtained in the perimeter colonized by pigeons in area B were overall lower than those determined in area A. This aspect can be explained by the reduction in the number of pigeons in area B, due to the regulations established at the city level, which prohibit feeding the pigeons. In area B, the number of pigeons has decreased recently, but the pigeon colony is maintained, mainly due to the presence of the water source. In area A, the pigeon colony is large and relatively constant due to the fact that pigeons are still fed and watered, area A being less supervised. In addition, in area B there is an intense human activity, the space being extremely populated. Being the central area of the city, the people carry out numerous recreational activities, which explains the fact that even at 100 meters

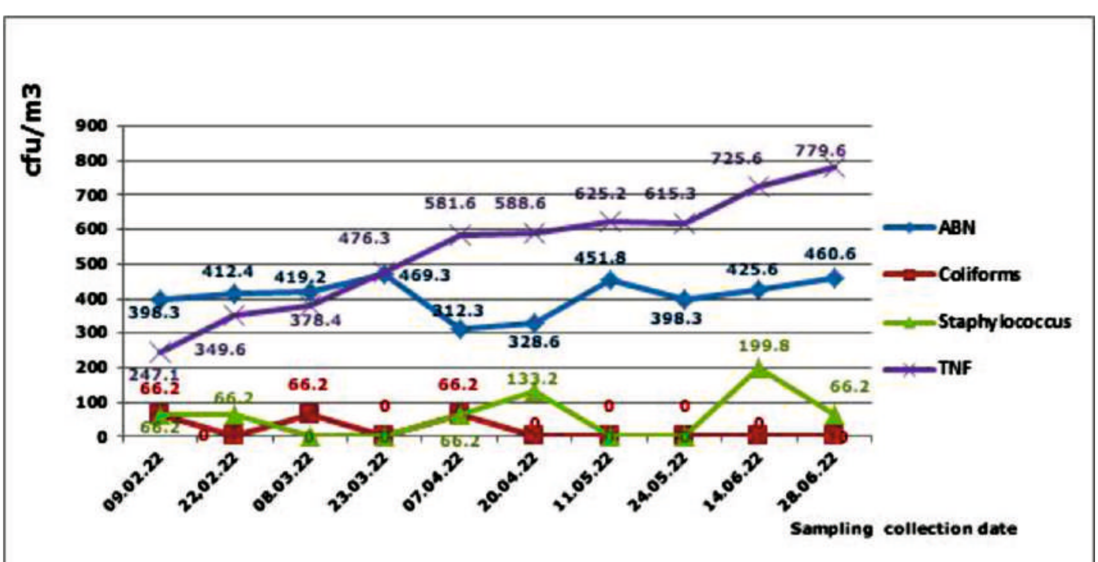

Fig. 6. Air microbial load at 100 meters from the pigeon colony, area B

from the pigeon colony, the number of coliforms and staphylococci is above the recommended limits.

The results obtained in this study are comparable to those of other researchers (19, 22). In a study carried out in a botanical garden by *Nandini* and *Sivasakthivel* (2014) in which microbial air pollution was monitored, it is specified that the highest microbial load was recorded in the pigeon feeding area, where the total number of aerobic mesophilic bacteria was 1.016 cfu/m³, and the total number of fungi was 3,040 cfu/m³. It was also found that the number of staphylococci in the air was 258 cfu/m³ (22).

Similar findings were observed by *Schulz et al.*, (2004), who showed that staphylococci are an important indicator of air quality because they usually indicate the presence of pathogenic bacteria on human and animal skin in the air (27). Although these bacteria do not produce spores, they have the ability to survive in the air for a long time, which means that certain infections can be spread through the air. If a large number of potentially pathogenic staphylococci is observed in the feeding place of pigeons, which exceeds the permissible limit, i.e., 25 cfu/m³, it is assumed that there is a risk to human health. The high levels of staphylococci are due to the large number of animals and a large number of visitors as well (27).

In the same study, *Enterococcus faecalis* and *E. coli* had values of 80 cfu/m3 and 210 cfu/m3, respectively, at the pigeon feeding place. According to the data of *Lues et al.,* (2007), the species *E. coli* and other coliform bacteria are a good indicator of faecal contamination of the environment and implicitly of the air. The presence of these bacteria in the air is due to their aerosolization from pigeon droppings (17). The bacteria frequently encountered in the industrial breeding of chickens are *Campylobacter spp., Staphylococcus spp., Salmonella spp., Clostridium perfringens, Enterococcus faecalis* and *Escherichia coli* species that can also be found in spaces populated by pigeons (2, 6, 17).

In the outdoor air, the diversity of fungal species is great. Some of these species are directly or indirectly pathogenic for humans. Fungi from the genera *Cladosporium, Alternaria, Penicillium* and *Aspergillus* have often been implicated in the development of respiratory allergies. *Cladosporium* airborne spores are significant categories of allergens, and in large quantities they can seriously affect asthmatics and people with other respiratory diseases. Prolonged exposure to high spore loads can weaken the immune system. However, the increased prevalence of fungi can induce type I and III allergies (26).

CONCLUSIONS

The microbial load of the air in places colonized by pigeons, in Timisoara city, recorded increased values for all the monitored microbiological indicators, which means intense pollution, if certain recommendations regarding air pollution are taken into account.

At a distance of 100 m from the pigeon colonies, the microbial load of the air had much lower values, for all indicators, but staphylococci and coliform bacteria sometimes exceeded the admitted values.

Considering the results of this study, attention is drawn to the health risk of children and the elderly persons, who may have a low immune status, by frequenting places populated by pigeons, and it is recommended to avoid them. Also, it is recommended to establish at national level some standardized methods for the collection and microbiological analysis of air samples and some norms regarding the maximum limits of air microbial load, allowed for the external environment and different types of habitats.

ACKNOWLEDGMENTS

This research paper was supported by the project: *Increasing the impact of excellence research on the capacity for innovation and technology transfer within USAMVB Timisoara*, code 6PFE, submitted in the competition Program 1: Development of the national system of research-development; Subprogram 1.2: Institutional performance, Institutional development projects-Development projects of excellence in RDI.

REFERENCES

1. *Bassi M., Chiatante D.*, (1976), The role of pigeon excrement in stone biodeterioration. Int Biodeterior, 12: 3–79
2. *Brooks J.P.,* (2010), Microbial and antibiotic resistant constituents associated with biological aerosols and poultry litter within a commercial poultry house. Sci Total Environ, 408(20):4770-4777
3. *Bucur I., Dumitrescu V., Imre K., Herman V., Nichita I., Cristina R.T., Tirziu E.*, (2020),Research on the frequency of resistance phenotypes in bacterial strains isolated from chamois (Rupicapra rupicapra carpatica), Revista Romana de Medicina Veterinara, 30 (1):66-70
4. *Casanovas L., de Simón M., Ferrer M. D., J. Arqués J., Monzón G.*, (1995), Intestinal carriage of *Campylobacters, Salmonellas, Yersinias* and *Listerias* in pigeons in the city of Barcelona, Journal of Applied Bacteriology, 78(1):11-13
5. *Čechová L., Halánová M., Zuzana Kalinová Z., Čisláková L., Halán M., Valenčáková A.*, (2016), Detection of *Chlamydia psittaci* in feral pigeons (*Columba livia domestica*) in Slovakia and their characterization. Ann Agric Environ Med, 23(1):75-78
6. *Chinivasagam H.N.*, (2009), Mechanically ventilated broiler sheds: a possible source of aerosolized *Salmonella, Campylobacter*, and *Escherichia coli*. *Appl Environ Microbiol*, 75(23):7417-7425
7. *Dell'Omo G., Morabito S., Quondam R., Agrimi U., Ciuchini F., Macrì A., Caprioli A.*, (1998), Feral pigeons as a source of verocytotoxin-producing *Escherichia coli*. *Vet Rec*, 142:309-310
8. *Farfán M.Á., Díaz-Ruiz F., Duarte J., Raimundo Real R.*, (2019), Feral pigeon (*Columba livia* var. domestica) management in low-density urban areas: preven-

tion is better than cure. Urban Ecosystems, 22:1027-1035

9. *Fernandez H., Gesche W., Montefusco A., Schlatter R.*, (1996), Wild birds as reservoir of thermophilic enteropathogenic *Campylobacter* species in southern Chile. Mem Inst Oswaldo Cruz, 91:699-700
10. *Fukata T., Uemura T., Baba E., Horiuchi S., Arakawa A.*, (1986), Isolation of *Clostridia, Salmonellae* and *Coccidia* from wild pigeons in Japan. Br Vet J, 142: 291-293
11. *Gruwell J.A., Fogarty C.L., Bennett S.G., Challet G.L., Vanderpool K.S., Jozan M., Webb J.P.,* (2000), The role of peridomestic birds in the transmission of St Louis encephalitis in southern California. J Wildl Dis, 36:13-34
12. *Haag-Wackernagel D., Geigenfeind I.*, (2008), Protecting buildings against feral pigeons. Eur J Wildl Res, 54:715-721
13. *Haag-Wackernagel D., Moch H.*, (2004), Health hazards posed by feral pigeons. Journal of Infection, 48: 307-313
14. *Kinjo T., Morishige M., Minamoto N., Fukushi H.*, (1983), Prevalence of *Campylobacter jejuni* in feral pigeons. Japanese Journal of Veterinary Science, 45: 833-835
15. *Komar N., Burns J., Dean C., Panella N. A., Dusza S., Cherry B.,* (2001), Serologic evidence for West Nile virus infection in birds in Staten Island, New York, after an outbreak in 2000. Vector Borne Zoonotic Dis, 1:191-196
16. *Komar N., Panella N.A., Burns J.E., Dusza S.W., Mascarenhas T.M., Talbot T.O.*, (2001), Serologic evidence for West Nile virus infection in birds in the New York City vicinity during an outbreak in 1999. Emerg Infect Dis, 7:621-625
17. *Lues J., Theron M., Venter P., Rasephei H.*, (2007), Microbial composition in bioaerosols of a highthroughput chicken-slaughtering facility. Poultry Science, 86: 142-149
18. *Magnino S., Haag-Wackernagel D., Geigenfeind I., Helmecke S., Dovc A., Prukner-Radovcić E., Residbegović E., Ilieski V., Laroucau K., Donati M., Martinov S., Kaleta F.E.,* (2009), Chlamydial infections in feral pigeons in Europe: Review of data and focus on public health implications. Vet Microbiol, 135 (1-2):54-67
19. *Małecka-Adamowicz M., Okoniewska A.*, (2010), Evaluation of microbial air quality in a forest recreation park. Polish J of Environ Stud, 19 (1):107-113
20. *Megraud F.,* (1987), Isolation of *Campylobacter spp*. from pigeon feces by a combined enrichment-filtration technique. Appl Environ Microbiol, 53:1394-1395
21. *Mendez-Tovar L.J., Mainou L.M., Pizarro S.A., Fortoul-Vandergoes T., Lopez-Martinez R.*, (1995), Fungal biodeterioration of colonial facades in Mexico City. Revista Mexicana de Micología, 11:33-144
22. *Nandini N., Sivasakthivel S.*, (2014), Microbiological pollution of air in Lal Bagh botanical gardens, Bangalore, Karnataka, India, International Journal of Science and Research (IJSR), 3(4):648-651
23. *Nichita I., Lupa L., Stoia M., Dragan E.S., Pop A.*, (2019), Aminophosphonic groups grafted onto the structure of macroporous styrene-divinylbenzene copolymer: preparation and studies on the antimicrobial effect. Polymer Bulletin, 76(9):4539-4557
24. *Plissier M., Andre S.,* (1976), Sur l'aptitude du pigeon urbain a developper des anticorps inhibant l'hemagglutination par le virus de la rubeole. Bul Acad Nat Med (Paris), 160:224-227
25. *Pop M.,* Bucur I*., Zoldan D., Imre K., Nichita I., Cristina G., Tirziu A. Tirziu E.*, (2022), Chemical and microbiological air quality in a municipal solid waste landfill and its surroundings, in South-Eastern Romania. Sustainability, 14:156
26. Radon K., Danuser B., Iversen M., Monso E., Weber C., Hartung J., Donham K.J., Palmgren U., Nowak D., (2002), Air contaminants in different European farming environments, Ann Agric Environ Med, 9:41-48
27. *Schulz J., Hartung J., Seedorf L., Formosa C.*, (2004), Staphylococci as an indicator for bacterial emissions from a broiler house. Proceeedings of International Society for Animal Hygiene- Sant-Maolo, 75-78
28. *Spennemann D.H.R., Pike M., Watson M.J.*, (2017), Effects of acid pigeon excreta on building conservation. Int J Build Pathol Adapt, 35:2-15
29. *Teslici L.E., Nichita I., Herman V., Olariu-Jurca I., Dracea A.D., Olariu-Jurca A.*, (2020), Morphopatological researches in the respiratory form of infectious avian bronchitis at pigeons, Revista Romana de Medicina Veterinara, 30(3):21-26
30. *Vázquez B., Esperón F., Neves E., Jesús Muñoz M., Ballesteros C.,* (2010), Screening for several potential pathogens in feral pigeons (*Columba livia*) in Madrid, Acta Veterinaria Scandinavica, 52(1):45-50.