Electrostatic Dust Cloth

Subjects: Others
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Electrostatic dust cloths (EDC) have been widely used for microbiologic contamination assessment in different indoor and occupational environments. Electrostatic dust cloths are negatively charged allowing dust particles to settle with greater ease.

Keywords: EDC

1. Exposure Assessment and the Use of Electrostatic Dust Cloths

Current sampling strategies used for microbial exposure assessment may ineffectively describe significant exposures. Even applying the state-of-the-art regarding analyses, the information can be biased if the sampling techniques are not properly selected [1]. Thus, it is critical to select the best sampling approach to allow the accurate measurement and identification of the microbiological agents present in the indoor environments to be assessed.

In a recent study performed by Adams et al. (2021) [2] in a school's environment and using electrostatic dust collectors (EDC) it was possible to identify the microorganisms related to inspection-based building moisture damage and then examine the links between those microbial exposures and health effects [2]. Indeed, this sampling method has been widely used for microbiologic contamination assessment in different indoor and occupational environments (Table 1). If the intention is to perform viability studies, the electrostatic cloth used should not be impregnated with any kind of biocide to avoid impairing the viability of the microorganisms viability.

This sampling method is appropriate for large-scale epidemiological studies intending to measure microbial exposure, and to complement exposure information collected by building inspections dedicated to spotting dampness and mold [3][4]. EDC is also being used to assess microbial contamination using molecular tools as stand-alone analyses [4][5][6][7][8], even the most refined ones such as sequencing [2], or using side by side, culture-dependent, and independent methods [3][9][10][11][12][13][14][15][16][17][18][19][20][21][22][23]. In fact, the use of qPCR analyses from EDC is a promising tool to accurately measure microbial contamination in dwellings [4][8][24]. Additionally, it has also been used to perform the fungal azole resistance screening in different indoor environments [12][13][14][15][16][17][18][19][20][21][22][23][24][25][26] and to identify MRSA presence and level of contamination in specific occupational environments [7]. Further, aside from microbial contamination, this sampling method has been applied to assess microbial metabolites, such as endotoxins [27][28][29] and mycotoxins [18][22]. Furthermore, the EDC was also used as a sampling method to measure antigen concentrations with enzyme immunoassays specific for storage mites [30].

2. Electrostatic Dust Cloths' Features

As all passive sampling methods, it allows a more integrated time exposure assessment (workshift, days, weeks, or months), since it can collect during different periods of time depending on the activities, work shifts, and expected contamination [2][15][17][18]. In fact, this sampling method can be applied for prolonged periods of time, and, because of that, they allow to overcome the major drawback of short-term active air sampling, which is highly sensitive to large temporal fluctuations in the airborne microbial load that might be associated to specific events that occur only sporadic in a specific workplace or indoor environment [4]. They have a very low cost (petri dish and an electrostatic cloth) and do not require microbiological training to set up and can be applied by the study subjects themselves in their dwellings [4]; however, in the workplaces, the EDC should be placed by a trained technician to select the proper sampling sites considering the study aim and the most suitable surfaces (preferably elevated surfaces at the height of 1.5–2.5 m) avoiding sampling sites with major airflow disturbances [2][15][17][18]. EDC placed on an elevated surface, besides collecting particles over a known time period, allows capturing airborne dust instead of floor-based particles that may never become sufficiently airborne to contribute to human exposure by inhalation [6]. Previously, a study performed by Madsen and colleagues (2012) [3] reported the need to place the EDC on open surfaces during sampling and that obtained can be frozen at −80 °C with glycerol without disturbing the microorganisms' number considerably [3].

3. The Role and Advantages of the EDC

EDC was one among the several sampling methods applied in the other studies reported in **Table 1**, presenting, in most of the studies, a higher number of passive methods than active sampling methods employed. In fact, besides being used in parallel with devices that allow air sampling, other different passive sampling methods were employed, such as surface

swabs and settled dust and different environmental matrices (e.g., filters from HVAC, mops, cleaning cloths, uniform ranks, and identification badges) were collected depending on the indoor environment/setting being assessed [11][12][13][14].

The sampling period used for the EDC varied between studies. Fifteen days of sampling was followed in the two studies dedicated to bakeries, while in the other occupational environments, 30 days were applied. This difference was due to the expected microbial contamination in the assessed indoor environments. In the assessed dwellings, some constraints were faced due to the occupant's availability when the sampling period ended, and although 30 days of sampling was to be followed, an extended period of sampling was performed in some cases. This difficulty was overcome by applying a different formula,

$$(\text{CFU.m-2.day} = (1\ x/(3.14*\text{EDC area}))/\text{days of sampling}) \quad (1)$$

where the sampling days were considered, to obtain fungal densities [21]. This different approach for the fungal density's quantification was the one followed after the first study performed in dwellings [16].

The protocol used was common to all studies where the EDC was employed in the dedicated sampling campaigns and following the procedures previously published [3] and as follows: Each EDC cloth was washed with 20 mL 0.9% NaCl with 0.05% Tween80™ (Merck S.A, Lisbon, Portugal) by orbital shaking (250 rpm, 60 min, at room temperature), and 150 µL of the wash suspension was inoculated on to two different culture media: 2% malt extract agar (MEA) with 0.05 g/L chloramphenicol media and dichloran glycerol (DG18) agar-based media. After incubation of the plates with the selected media, bacteria and/or fungal densities were determined.

In all studies, the fungal contamination was characterized focusing on *Aspergillus* genera due to clinical and toxicological relevance from the *Aspergillus* sections [12][21], EDC provided information concerning fungal azole resistance in all the performed studies presented in **Table 1**, unveiling more data regarding this public and occupational health threat. Additionally, it was also possible to focus on *Aspergillus* sections indoors [12][21], as well as other fungal species, providing a more complete fungal characterization with a wider number of different fungal species being identified than the other active and passive sampling methods [13][14][17][18][20][31]. Although the bakeries setting presented the highest fungal contamination due to the role as contamination sources of the raw materials [10][14], the setting presenting the highest *Aspergillus* sp. contamination was the FFH due to the observed buildings damage and leakages [21]. Mycotoxin's detection [18][22] and cytotoxicity assessment using different cell lines [13][18][23] were also assays employed in enlarged studies dedicated to microbiologic agents.

Almost all the studies used culture-based methods and qPCR for the detection of *Aspergillus* sections. The exception, where only culture-based methods were applied, was in the study performed in 12 bakeries [10], the study performed in different settings where molecular identification was achieved [31], and a study concerning *Aspergillus* section *Fumigati* where the isolates were recovered by culture-based methods for further analyses [23]. In the studies where culture-based methods and qPCR detection were applied side by side, complementary results were obtained with higher detection of *Aspergillus* sections, mainly section *Fumigati*, by molecular tools.

Table 1. Studies performed in Portugal to assess indoor exposure to microbial contamination by using EDC.

Indoor Environment	Study Goal	Sampling Methods	Analyses Performed to EDC	Most Relevant
One veterinary clinic	**Assessment of organic dust and microbial contamination in a typical Portuguese veterinary clinic, including azole-resistant fungi.**	**Active (air impaction N = 8) and passive (surfaces N = 8 and EDC N = 3)**	**Culture-based methods (fungi and bacteria and azole resistance screening) and qPCR (*Aspergillus* sections detection)**	**EDC res *equisetii***
Twelve bakeries	**To analyze the adequacy of EDC for identifying the distribution patterns and exposure concentrations of particulate matter and microbial contaminants in bakeries.**	**Passive sampling method (EDC N = 33) and Particle counts and size distribution (0.3 µm, 0.5 µm, 1 µm, 2.5 µm, 5 µm, and 10 µm) measurement**	**Culture-based methods (bacteria and fungi)**	**Higher EDC fungal load different dim**
Thirteen bakeries	**To assess workers´ exposure to fungi and mycotoxins in Portuguese bakeries.**	**Active methods (Air impaction and impingement each N = 53) and passive (surface swabs N = 58, EDC N = 36 and settled dust N = 11) methods**	**Culture-based methods (fungi) and qPCR (*Aspergillus* sections)**	***A.* section *Fu* it was possi**

Indoor Environment	Study Goal	Sampling Methods	Analyses Performed to EDC	Most Relevant
Ten Primary Health Care Centres (PHCC)	*Aspergillus* distribution assessment in 10 PHCC	Active (impaction N = 81 and impingement N = 41) and passive (surface swabs N = 81, EDC N = 81, settled dust N = 10, and filters from HVAC system N = 12) methods	Culture-based methods (*Aspergillus* prevalence) and qPCR (*Aspergillus* sections)	*Fumigati* s
	To analyze the adequacy of EDC for identifying critical workstations of occupational exposure to particulate matter and for characterizing the microbial contamination present in 10 PHCC.	Particle counts and size distribution were measured with direct-reading equipment. Passive sampling method (EDC N = 81)	Culture-based methods (bacteria and fungi) and qPCR (*Aspergillus* sections)	In MEA *A.* se (0.01%) and
One Central Hospital from Oporto	To assess the exposure to bioburden in one central hospital with a multi-approach protocol using active and passive sampling methods.	Active methods (impaction N = 120, filtration N = 2, and impingement N = 15) and passive (surface swabs N = 45, EDC N = 15 and settled dust N = 5; HVAC filter samples N = 2)	Culture-based methods (fungi and bacteria and azole resistance screening) and qPCR (*Aspergillus* sections). Mycotoxins and endotoxins profile were also assessed. Two cytotoxicity assays were conducted with two cell lines and in vitro pro-inflammatory potential was assessed	*Fumigati* se culture-indepe
Different occupational and nonoccupational indoor settings	Molecular identification of *Aspergillus* species collected	Several environmental matrices depend on the indoor environment. EDC was used in 4 out of the 7 environments assessed	Culture-based methods *(Aspergillus* and azole resistance screening from the isolates) and molecular identification	Five *Aspergi* for further ana = 1), *A. fumig*
One Central Hospital from Lisbon	Bioburden assessment with two passive sampling methods (ventilations grids swabs and electrostatic dust collectors (EDC) at Clinical Pathology Services.	Surface swabs (N = 30) from ventilation grids and EDC (N = 16)	Culture-based methods (fungi and bacteria and azole resistance screening) and qPCR (*Aspergillus* sections). Mycotoxins assessment and cytotoxicity profile was also performed	*Aspergillus* se
Thirty-three dwellings and four schools	To assess microbial contamination in the indoor microenvironments more frequented by children	PM2.5 and PM2.5–10 was sampled with a medium volume sampler. EDC was placed in the living room (N = 33) and in the children's bedroom (N = 31), and in schools (N = 4)	Culture-based methods (fungi and bacteria and azole resistance screening) and qPCR (*Aspergillus* sections)	The fungal was *Penicilli* foun prevalent. *As* observed in
Twenty-three dwellings	To assess settleable dust loading rates and microbial contamination in Portuguese dwellings by passive sampling (quartz fiber filters and EDC, respectively.)	Quartz fiber filters were placed side by side With EDC in summer (N = 79) and winter (N = 78)	Culture-based methods (fungi and bacteria and azole resistance screening) and qPCR (*Aspergillus* sections)	Dust and mic in the summe the most pre by *Aspergill* increased i season, *Aspe* media; *Aspe*
Ten dwellings	Assessment of the bioburden during sleeping periods in Portuguese dwellings through active (air sampling) and passive (EDC) methods	Active sampling using a MAS-100™ air sampler equipment and EDC (from 7 bedrooms, 4 living rooms, and 1 kitchen) (N = 12)	Culture-based methods (fungi and bacteria and azole resistance screening) and qPCR (*Aspergillus* sections)	In bedrooms M was *Aspe* and *Cladosp* was *Penicilliu* in EDC range DG18
Thirty dwellings	To assess the deposition rates of total settleable dust and microbial contamination in the indoor air of dwellings onto quartz fiber filters andEDC, respectively	47 mm diameter quartz fiber filters were exposed to collect particulate matter and EDC (N = 30) were used for microbial contamination characterization	Culture-based methods (fungi and bacteria and azole resistance screening) and qPCR (*Aspergillus* sections)	Fungal c m^{-2} day^{-1} m^{-2} day^{-1} i MEA (36.2

Indoor Environment	Study Goal	Sampling Methods	Analyses Performed to EDC	Most Relevant
Twelve ambulances vehicles	Assessment of the bioburden in Portuguese ambulances using active and passive sampling methods.	336 air samples through impaction method, 132 surface swabs, 7 mops, and cleaning cloths, 3 uniform ranks, 13 settled dust samples, and 14 EDC	Culture-based methods (fungi and bacteria and azole resistance screening) and qPCR (*Aspergillus* sections) and mycotoxins detection	Fungal value and 0 (to 28. most preva
Eleven Firefighters headquarters (FFH)	Characterization of *Aspergillus* section *Fumigati* distribution in 11 firefighter headquarters (FFHs) to obtain an accurate occupational exposure assessment.	Active (air impaction method) (N = 760) and passive sampling methods (floor surfaces swabs (N = 90), electrostatic dust collectors (EDC) (N = 82), settled dust (N = 11), filters used for sampling the settled dust (N = 90), firefighter uniform badges (N = 67), cleaning cloths (N = 25) and mops N = 14).	Culture-based methods (fungi and azole resistance screening) and qPCR (*Aspergillus* sections)	*Aspergillus* (0.55%), where The among *Asper* Concerning a were identifi settled dust. of 4.4% in ED 100%) and same sectio samples, w h
Health Care Environments (10 Primary Health Care Environments (PHCC) and 1 Central Hospital (CH))	Cytotoxicity evaluation of *Aspergillus* section *Fumigati*	Active sampling (air sampling by impaction N = 201 andimpigment N = 56 for molecular detection purposes). Passive sampling (surface swabs–N = 126; EDC, N = 96; settled dust N = 15; and filters from HVAC system N = 12). Nasal swabs were collected from volunteer health care workers in the 10 PHCC (N = 25) and in the CH (N = 22).	*Aspergillus* Section *Fumigati* isolation by culture-based methods (including azole resistance screening) and cytotoxicity assessment in lung epithelial cells and kidney cells using the MTT assay.	1 isolate w cytotoxici

Since during EDC extraction, the recovery of microbial contamination can be partially lost (as in all sampling methods) [3], the recommendation is to use more than one sampling method in exposure assessments [32], being the EDC a suitable sampling method to complement active sampling methods, as well as to be used in parallel with more specific passive methods, that can be adjusted to the indoor environment under study (for instance filters from forklifters´ HVAC, identification badges from ambulances crew, …).

Although the trend is to apply more refined molecular tools to obtain the fungal diversity from the indoor environment to be assessed [2], since the viable part constitutes only a reduced part of the total composition [33] in exposure assessments culture-based methods are still needed to be applied to allow: (a) guidelines and legal framework comparison [12][21]; (b) to draw conclusions regarding the inflammatory potential variation, since the inflammatory and/or cytotoxic potential can affect the fungal viability [34][35] and; (c) to recover isolates for azole resistance screening, sequencing and mutations detection [31][36].

The findings also suggest that EDC can be applied as a screening method for particulate matter-exposure assessment and as a complementary method to quantify fungal contamination exposures in indoor environments [10][13].

References

1. Mendell, M.J.; Adams, R.I. The Challenge for Microbial Measurements in Buildings. Indoor Air 2019, 29, 523–526.
2. Adams, R.I.; Leppänen, H.; Karvonen, A.M.; Jacobs, J.; Borràs-Santos, A.; Valkonen, M.; Krop, E.; Haverinen-Shaughn essy, U.; Huttunen, K.; Zock, J.-P.; et al. Microbial Exposures in Moisture-Damaged Schools and Associations with Res piratory Symptoms in Students: A Multi-Country Environmental Exposure Study. Indoor Air 2021, 31, 1952–1966.
3. Madsen, A.M.; Matthiesen, C.B.; Frederiksen, M.W.; Frederiksen, M.; Frankel, M.; Spilak, M.; Gunnarsen, L.; Timm, M. Sampling, Extraction and Measurement of Bacteria, Endotoxin, Fungi and Inflammatory Potential of Settling Indoor Dus t. J. Environ. Monit. 2012, 14, 3230–3239.
4. Shorter, C.; Täubel, M.; Pierse, N.; Douwes, J.; Howden-Chapman, P.; Hyvärinen, A.; Crane, J. Objective Assessment of Domestic Mold Contamination Using Quantitative PCR. J. Allergy Clin. Immunol. 2016, 137, 622–624.
5. Van Cleef, B.A.G.L.; van Benthem, B.H.B.; Verkade, E.J.M.; van Rijen, M.; den Bergh, M.F.Q.K.; Schouls, L.M.; Duim, B.; Wagenaar, J.A.; Graveland, H.; Bos, M.E.H.; et al. Dynamics of Methicillin-Resistant Staphylococcus Aureus and M

ethicillin-Susceptible Staphylococcus Aureus Carriage in Pig Farmers: A Prospective Cohort Study. Clin. Microbiol. Infect. 2014, 20, O764–O771.

6. Adams, R.I.; Tian, Y.; Taylor, J.W.; Bruns, T.D.; Hyvärinen, A.; Täubel, M. Passive Dust Collectors for Assessing Airborne Microbial Material. Microbiome 2015, 3, 46.
7. Bos, M.E.H.; Verstappen, K.M.; van Cleef, B.A.G.L.; Dohmen, W.; Dorado-García, A.; Graveland, H.; Duim, B.; Wagenaar, J.A.; Kluytmans, J.A.J.W.; Heederik, D.J.J. Transmission through Air as a Possible Route of Exposure for MRSA. J. Expo. Sci. Environ. Epidemiol. 2016, 26, 263–269.
8. Cox, J.; Indugula, R.; Vesper, S.; Zhu, Z.; Jandarov, R.; Reponen, T. Comparison of indoor air sampling and dust collection methods for fungal exposure assessment using quantitative PCR. Environ. Sci. Process. Impacts 2017, 19, 1312–1319.
9. Ege, M.J.; Mayer, M.; Normand, A.-C.; Genuneit, J.; Cookson, W.O.C.M.; Braun-Fahrländer, C.; Heederik, D.; Piarroux, R.; von Mutius, E. Exposure to Environmental Microorganisms and Childhood Asthma. N. Engl. J. Med. 2011, 364, 701–709.
10. Viegas, C.; Monteiro, A.; Carolino, E.; Viegas, S. Occupational Exposure to Bioburden in Portuguese Bakeries: An Approach to Sampling Viable Microbial Load. Arch. Ind. Hyg. Toxicol. 2018, 69, 250–257.
11. Viegas, C.; Monteiro, A.; Ribeiro, E.; Caetano, L.A.; Carolino, E.; Assunção, R.; Viegas, S. Organic Dust Exposure in Veterinary Clinics: A Case Study of a Small-Animal Practice in Portugal. Arch. Ind. Hyg. Toxicol. 2018, 69, 309–316.
12. Viegas, C.; Almeida, B.; Gomes, A.Q.; Carolino, E.; Caetano, L.A. Aspergillus Spp. Prevalence in Primary Health Care Centres: Assessment by a Novel Multi-Approach Sampling Protocol. Environ. Res. 2019, 175, 133–141.
13. Viegas, C.; Almeida, B.; Monteiro, A.; Paciência, I.; Rufo, J.; Aguiar, L.; Lage, B.; Diogo Gonçalves, L.M.; Caetano, L.A.; Carolino, E.; et al. Exposure Assessment in One Central Hospital: A Multi-Approach Protocol to Achieve an Accurate Risk Characterization. Environ. Res. 2020, 181, 108947.
14. Viegas, C.; Faria, T.; Caetano, L.A.; Carolino, E.; Quintal-Gomes, A.; Twarużek, M.; Kosicki, R.; Viegas, S. Characterization of Occupational Exposure To Fungal Burden in Portuguese Bakeries. Microorganisms 2019, 7, 234.
15. Viegas, C.; Santos, P.; Almeida, B.; Monteiro, A.; Carolino, E.; Gomes, A.Q.; Viegas, S. Electrostatic Dust Collector: A Passive Screening Method to Assess Occupational Exposure to Organic Dust in Primary Health Care Centers. Air Qual. Atmos. Health 2019, 12, 573–583.
16. Viegas, C.; Almeida, B.; Dias, M.; Caetano, L.A.; Carolino, E.; Gomes, A.Q.; Faria, T.; Martins, V.; Marta Almeida, S. Assessment of Children's Potential Exposure to Bioburden in Indoor Environments. Atmosphere 2020, 11, 993.
17. Viegas, C.; Dias, M.; Almeida, B.; Vicente, E.; Caetano, L.A.; Carolino, E.; Alves, C. Settleable Dust and Bioburden in Portuguese Dwellings. Microorganisms 2020, 8, 1799.
18. Viegas, C.; Twarużek, M.; Lourenço, R.; Dias, M.; Almeida, B.; Caetano, L.A.; Carolino, E.; Gomes, A.Q.; Kosicki, R.; Soszczyńska, E.; et al. Bioburden Assessment by Passive Methods on a Clinical Pathology Service in One Central Hospital from Lisbon: What Can It Tell Us Regarding Patients and Staff Exposure? Atmosphere 2020, 11, 351.
19. Viegas, C.; Dias, M.; Almeida, B.; Vicente, E.; Candeias, C.; Aranha Caetano, L.; Carolino, E.; Alves, C. Loading Rates of Dust and Bioburden in Dwellings in an Inland City of Southern Europe. Atmosphere 2021, 12, 378.
20. Viegas, C.; Dias, M.; Monteiro, A.; Faria, T.; Lage, J.; Carolino, E.; Caetano, L.A.; Gomes, A.Q.; Almeida, S.M.; Verde, S.C.; et al. Bioburden in Sleeping Environments from Portuguese Dwellings. Environ. Pollut. Barking Essex 2021, 273, 116417.
21. Viegas, C.; Gomes, B.; Dias, M.; Carolino, E.; Aranha Caetano, L. Aspergillus Section Fumigati in Firefighter Headquarters. Microorganisms 2021, 9, 2112.
22. Viegas, C.; Sousa, P.; Dias, M.; Caetano, L.A.; Ribeiro, E.; Carolino, E.; Twarużek, M.; Kosicki, R.; Viegas, S. Bioburden Contamination and Staphylococcus Aureus Colonization Associated with Firefighter's Ambulances. Environ. Res. 2021, 197, 111125.
23. Viegas, C.; Twarużek, M.; Almeida, B.; Dias, M.; Ribeiro, E.; Carolino, E.; Soszczyńska, E.; Caetano, L.A. Cytotoxicity of Aspergillus Section Fumigati Isolated from Health Care Environments. J. Fungi 2021, 7, 839.
24. Naegele, A.; Reboux, G.; Vacheyrou, M.; Valot, B.; Millon, L.; Roussel, S. Microbiological consequences of indoor composting. Indoor Air 2016, 26, 605–613.
25. Caetano, L.A.; Faria, T.; Batista, A.C.; Viegas, S.; Viegas, C. Assessment of Occupational Exposure to Azole Resistant Fungi in 10 Portuguese Bakeries. AIMS Microbiol. 2017, 3, 960–975.
26. Caetano, L.A.; Faria, T.; Springer, J.; Loeffler, J.; Viegas, C. Antifungal-Resistant Mucorales in Different Indoor Environments. Mycology 2019, 10, 75–83.
27. Noss, I.; Wouters, I.M.; Visser, M.; Heederik, D.J.J.; Thorne, P.S.; Brunekreef, B.; Doekes, G. Evaluation of a Low-Cost Electrostatic Dust Fall Collector for Indoor Air Endotoxin Exposure Assessment. Appl. Environ. Microbiol. 2008, 74, 5621–5627.
28. Jacobs, J.H.; Krop, E.J.M.; Borras-Santos, A.; Zock, J.-P.; Taubel, M.; Hyvarinnen, A.; Pekkanen, J.; Doekes, G.; Heederik, D.J.J.; HITEA Schools Study Consortium. Endotoxin Levels in Settled Airborne Dust in European Schools: The HITEA School Study. Indoor Air 2014, 24, 148–157.

29. Kilburg-Basnyat, B.; Metwali, N.; Thorne, P.S. Performance of Electrostatic Dust Collectors (EDCs) for Endotoxin Assessment in Homes: Effect of Mailing, Placement, Heating and Electrostatic Charge. J. Occup. Environ. Hyg. 2016, 13, 85–93.
30. Zahradnik, E.; Sander, I.; Kendzia, B.; Fleischer, C.; Brüning, T.; Raulf-Heimsoth, M. Passive Airborne Dust Sampling to Assess Mite Antigen Exposure in Farming Environments. J. Environ. Monit. 2011, 13, 2638–2644.
31. Simões, D.; Aranha Caetano, L.; Veríssimo, C.; Viegas, C.; Sabino, R. Aspergillus Collected in Specific Indoor Settings: Their Molecular Identification and Susceptibility Pattern. Int. J. Environ. Health Res. 2021, 31, 248–257.
32. Reponen, T. Sampling for Microbial Determinations. In Exposure to Microbiological Agents in Indoor and Occupational Environments; Viegas, C., Viegas, S., Gomes, A., Täubel, M., Sabino, R., Eds.; Springer International Publishing: Cham, Switzerland, 2017; pp. 85–96.
33. Jürgensen, C.W.; Madsen, A.M. Influence of Everyday Activities and Presence of People in Common Indoor Environments on Exposure to Airborne Fungi. AIMS Environ. Sci. 2016, 3, 77–95.
34. Timm, M.; Madsen, A.M.; Hansen, J.V.; Moesby, L.; Hansen, E.W. Assessment of the Total Inflammatory Potential of Bioaerosols by Using a Granulocyte Assay. Appl. Environ. Microbiol. 2009, 75, 7655–7662.
35. Croston, T.L.; Nayak, A.P.; Lemons, A.R.; Goldsmith, W.T.; Gu, J.K.; Germolec, D.R.; Beezhold, D.H.; Green, B.J. Influence of Aspergillus Fumigatus Conidia Viability on Murine Pulmonary MicroRNA and MRNA Expression Following Subchronic Inhalation Exposure. Clin. Exp. Allergy J. Br. Soc. Allergy Clin. Immunol. 2016, 46, 1315–1327.
36. Gonçalves, P.; Melo, A.; Dias, M.; Almeida, B.; Caetano, L.A.; Veríssimo, C.; Viegas, C.; Sabino, R. Azole-Resistant Aspergillus Fumigatus Harboring the TR34/L98H Mutation: First Report in Portugal in Environmental Samples. Microorganisms 2021, 9, 57.