Efficiency of Odonil air sanitizer spray to combat bioaerosol load in indoor public spaces.

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Abstract

The indoor air is one of the important factors which have direct effect on occupants. Especially for children and elderly people who have immunological depressed the effect is seen in high frequency

The indoor air gets polluted by many sources such as outdoor air, building materials, and indoor occupants, hygiene of toilets, air circulation, air exchange ratio and ventilation. The microbial pollution has higher impacts and long-lasting on indoor occupants. To manage indoor bioaerosol load Dabur Pvt.Ltd has formulated air sanitizer spray to resist bioaerosol load in indoor public spaces. Two formulations by name Odonil Citrus cline and Odonil nature pure were tested in different indoor environment. The efficiency study reviles that both the air sanitizer spray are very active against viable bacterial and fungal aerosol. The spray has biocide activity against bioaerosol load in indoor environment. the Odonil Nature pure has an average of 89.4% and Odonil Citrus clean has an average of 91% efficiency after 10miutes of spray and gradually reduces 18.8% and 22% after lapse of 60mintes. The Odonil Citrus clean air sanitizer is found to be having slightly higher efficiency than Odonil nature pure.

Keywords: *Indoor Environment, air sanitiser, Bioaerosol, immunological depressed, Efficiency of air sanitizer*

Introduction

Ambient Air pollution is now a global concern. Adverse environmental conditions pave path to have an impact on human health, flora and fauna. According WHO (2020), asthma kills around 4,61,000 people in 2019 and effects as many as 262 million people and prevalence is rising low and middle income countries disproportionally suffer the most severe cases. An Indian study on Epidemiology of Asthma, respiratory symptoms and chronic Bronchitis (Jindal *et al.*,2012) reports that, 17.25 million Indians suffer from Asthma.

People in metropolitan cities are facing different pulmonary problems during the onset of different seasons. Bengaluru being a metropolitan city has become a hub of allergic patients, as it has a prevalence of asthma at 9%, 10.5%, 18.5%, 24.5% and 29.5% during the year 1979,1984,1986,1994 and 1999 respectively (Paramesh, 2002). The present scenario is much more serious due to the exponential growth of the city vertically as well as poor air quality, urbanization and urban sprawl. Indoor air quality (IAQ) refers to quality of air in buildings and occupied spaces which is an important parameter, because people spend most of their life inside a built-up environment.

These built-up areas can be offices, hospitals, classrooms, laboratories, libraries, house or an apartment, auditoriums, cinema theatres, shopping malls etc. Buildings have undergone radical changes over past few decades, thereby resulting in less opportunity to exchange indoor air and outdoor air. In indoor air, gases are constantly under movement which carries contaminants from outside environment. The sources are from sewage treatment plants, open solid waste dump, composting units and public bathrooms, toilets, manufacturing units, paint shops etc., will influence the quality of indoor air.

Most of the factors mentioned above have led to the increased concentration of air pollutants like dust, bioaerosol, volatile organic compounds, carbon dioxide (CO_2) and carbon monoxide etc., within the residential spaces. Environment Protection

Agency (EPA) Guidelines for Indoor air quality, (2019) indicates that, indoor levels of pollutants may be 2-5 times and occasionally more than 100 times higher than outdoor levels.

The long time exposure is associated with abnormal health issues in building occupants. The most common problems associated to bad indoor air quality is Sick building syndrome (SBS), it is a medical condition where people in a building suffer from symptoms of illness or feel unwell. The symptoms tend to increase in severity with the time people spend in the buildings and improve over time or even disappear when people are away from the building.

Indoor Bioaerosol may originate from microbial, plant or animal sources and combines with natural or artificial particles, which get suspended in the air. These particles are also referred to as organic dust. Bioaerosol may consist of bacteria, fungi, spores, and pollen and cell fragments of microbes.

According to World Health Organization the main symptoms such as headache, eye, nose and throat irritation, fatigue, dizziness, difficulty in concentrating chest tightness and nausea are due to sick building syndrome, complaints are related to poor indoor air quality. (Apter *et al.*,1994). It has become very important to identify different risk factors and establish exposure threshold limit for microbial and chemical pollutants. Characterizing and quantifying the pollutants help in taking appropriate measures to control pollutants which are also of biological origin. The use of indoor air sanitizer to control the air contaminants is gaining importance during these days as it is one step solution, and it also comes with multiple fragrances. Thus the Objectives of the study is to evaluate biological air quality in various indoor environment before and after Odonil spray, and to assess the efficiency of two different **ODONIL indoor air sanitizer Aerosol spray namely**; **Nature pure** and **Citrus clean indoor air sanitizer** in combating microbial pollutant load in the indoor environment.

Materials and Methods

The current Study designed to check the efficacy of Odonil aerosol spray- **Nature Pure and Citrus Clean** on indoor airborne microorganism's load, with two principal components, each of which was executed using environmental or biological sampling or a combination of both. The environmental sampling was cross-sectional in indoor environment of seminar hall, rest room/toilets, libraries, health centres and auditorium. The specification of dimension of sampling sites and air exchange in indoor space (Table1)

Table1: sampling location, dimension, and air exchange in indoor space

Sampling site	**Room Dimension**	**Volume of air**	**Air exchange in m^3 / hour**
Toilets	6ftX9ft	$14m^3$	9.8
Seminar Hall Non AC	10ftX24ft	60 m^3	8
Library	115ftX 72ft	6545 m^3	11
Health care Centre	10ftX8ft	22 m^3	9
Auditorium(AC)	82ftX98ft	4124 m^3	13

Test Chemicals

The two test material under consideration for the study is **Dabur air sanitizer Aerosol spray - Nature Pure** and **Citrus clean**. The general composition of test aerosol spray is tabulated in Table 2 Both the test chemicals are discharging 0.25ml of aerosol in one spray.

Table 2 Chemical composition of ODONIL aerosol spray

Odonil- Nature pure 170g/300ml	**Odonil- Citrus clean** 170g/300ml
Ingredients	Ingredients
Fragrance Delight	Fragrance Lemon
Triethyleneglycol	Triethyleneglycol
Isopropyl Alcohol	Isopropyl Alcohol
--	Pine oil
Deodorized LPG	Deodorized LPG

Sampling and Testing of Indoor environmental conditions, Bacterial and fungal aerosol

Measurement of Indoor environmental conditions: Indoor Air Sampling was carried out following standard methods prescribed ASTM (2014) E1370-14 Preliminary examination of sampling sites was carried out and standard temperature, relative humidity, carbon dioxide and carbon monoxide concentration was measured using wet and dry bulb thermometer and expressed in degree Celsius, relative humidity was expressed in percentage, oxides of carbon were measured using digital CO2 and CO meter and expressed in part per million (ppm) levels.

The **Odonil Nature pure** and **Citrus clean** aerosol spray are sampled and tested by following standard procedures prescribed by US EPA (1980). Anderson single stage Microbial air Sampler (HiMedia make), system (LA474)(Anderson, 1958) with technical specification of sieve impaction 100 L/min flow rate,10% water loss after sampling $1m^3$ of air, 1.3µm particle size cut off , having 340 perforations are used for sampling.

Odonil Air sanitizers are tested during working hours at all sampling sites which were under consideration. Before carrying out the Odonil aerosol spray test, all ventilations of the sampling sites were closed. Bacterial bioaerosol, fungal bioaerosol, sampling was carried out. The sampler was set at a height of 147 cm above the ground level to collect samples of representative of the breathing zone.

Difference of two days is maintained at each sampling sites for testing Odonil nature pure and citrus clean spray. Odonil aerosol spray are sprayed in the corner and centre of the rooms and the number of spray were determined according to the room dimension (Table.3) and care was taken for uniform dispersion of air sanitizer all along the breathing zone in the sampling site. Air samples are taken before and after spraying, further 10 minutes time gap for bacterial aerosol sampling was given for reaction and sampling continued after 10, 20, 40 and 60 minutes. Fungal aerosol sampling was carried out after 30 minutes of spraying.

Table.3 Sampling site, dimension and number of spray

Sampling Site	Room Dimension	Number of Spray	Total discharged aerosol quantity in ml
Toilet	6ft X 9ft	10	2.5
Seminar Hall non AC	10ft X 24ft	25	6.25
Library	115ft X 72ft	35	8.75
Health centre	10ft X 8ft	15	3.75
Auditorium AC	82ft X 98ft	30	7.5

Enumerations of indoor bacterial and fungal aerosol

Selective, enrichment and differential media like Aeromonas isolation media, Streptococcus isolation media, Salmonella isolation media, Mannitol agar and McConkey agar media were used. Sampled Bacterial plates were incubated at 37°C, colonies counted after 24 hrs and 48 hrs.

Enumerations of bacterial isolates were carried out following APHA, (2012) by Standard plate count (viable count) method. A viable cell count was done by Digital microbial colony counter (Model DCC100). Total numbers of viable cells are reported as colony forming units forming units (CFUs) per meter cube Identification of bacterial isolates was done by culture method, morphological, microscopic examinations followed by biochemical test. Cowan's and Steel (1964), Bergey's manual of Systematic bacteriology (2009).

Isolation, enumeration and identification of fungal aerosol were carried out in triplicates. Laboratory media blank and field blank is maintained at all sampling sites. Incubated at 25 °C and 37 °C up to 7 days for moulds growth, since fungi grow best at 37 °C, while filamentous fungi grow at 25 °C. Total number of fungal colonies appeared on the surface of the grid/squares were reported as colony forming unit. Identified using light microscopy based on fungal morphology by following standard methods. (Barnets, 1972; Ellis, 1971)

Result and discussion

Indoor Environmental Conditions

Indoor environmental conditions play a significant role on human health, as modern industrialized society spends most of their time in an indoor environment such as, home, at the workplace, shops, a wide variety of recreation places, restaurants, cafeterias, theatres, cinemas, galleries, health centres, shopping malls etc), during transportation like travelling by train, bus and by air, etc. (Markov. 2002). The basic Environmental factors influencing indoor environment are temperature, radiation, humidity, Carbon dioxide concentration, carbon monoxide concentration, air velocity, ventilation, and dampness (Table-4).

Table 4: Indoor Environmental condition at sampling site

Sampling Site	WHO standard (2018) for indoor Temp 18-24°C	WHO standard indoor RH (2018) 40-60%	CO_2 WHO standard (2018) 400- 1000pp m	CO WHO standard (2018) 0-9ppm
Toilets	26.5	44.5	520	0
Seminar hall non AC	27	55	400	0
Library	25.4	66	550	0
Health care centre	26.4	56.8	514	1
Auditorium AC	21.5	66.5	505	1

Indoor temperature and relative humidity

The measured temperature (table 4) at sampling sites are found to be slightly higher than prescribed WHO limit of 18 to 24°C at all the sampling site except Auditorium AC. The humidity recorded at sampling sites was found to be within the prescribed limit of 40 -60% by WHO 2018. Relative humidity between 40% and 60% do not have a major impact on thermal comfort. If relative humidity is higher than 60% means the indoor environment has a lot of water vapor in the air, which favors the prevalence and propagation of bioaerosol in the indoor environment.

Temperature and humidity together have a strong and significant impact on the indoor air quality, at a constant pollution level, the perceived air quality decreases with increasing air temperature and humidity. Similar findings have been reported by Arundel *et al.,* (1986) of the health effects of relative humidity in indoor environments suggests that, relative humidity increases the incidence of respiratory infections and allergies. Most species of fungi cannot grow unless the relative humidity exceeds 60%. Relative humidity also affects the rate of off-gassing of formaldehyde from indoor building materials, the rate of formation of acids and salts from sulfur and nitrogen dioxide, and the rate of formation of ozone.

Carbon dioxide (CO_2) and Carbon monoxide (CO)

Carbon dioxide levels recorded at sampling sites are within the WHO, (2018) limit of 400-1000ppm. The elevated levels of CO_2 are positively correlated with bad ventilation which promotes transmission of respiratory infections. Daily 2.5hr exposure of CO_2 concentration above 600- 1000ppm will have an adverse effect on decision making and performance at the workspace. The concentration of CO_2 and other pollutants will gradually rise due to improper or lack of ventilation inside the room. The higher levels of carbon dioxide concentration inside the room rises the temperature.

The **carbon monoxide** levels were recorded nil at all the sampling area except in Health care centre and Auditorium AC recorded as 1 ppm but still is within the WHO (2018) limit of 0-9ppm. The elevated levels of CO in indoor will have influence on oxygen uptake by the lungs, intern lowers the immune system of indoor occupants. Hence indoor occupants are susceptible to infections at lower indoor bioaerosol concentration. The elevated levels will also have influence on temperature and relative humidity and favour the elevated levels of microbes

Biocidal activity of ODONIL air sanitizer Aerosol spray in indoor environment

The biocidal activity of ODONIL **Nature pure** on bacterial aerosol is 91% within 10 mins. However, the biocidal efficiency is decreased after 20 mins to 68%, after 40 mins to 46% and 18% after 60 mins. Similarly, ODONIL **Citrus clean** biocide activity is recorded as 93 % within 10 mins. However, the biocide efficiency is decreased after 20 mins to 72%, after 40 mins to 49% and 23% after 60 mins (table.5). On an average, the biocidal activity of citrus clean on bacterial aerosol is efficient (59 %) than Nature pure (56%) in indoor environmental condition (table 5)

Table: 5 Percent efficiency of Nature pure and Citrus Clean Spray on bacterial aerosol at sampling sites

Sr. No	Sampling Site	No.Spray	Test chemical	Before spray CFU/m^3	% Reduction of bacterial aerosol After spray			
					10min	20min	40min	60min
1	Toilets	10	Nature Pure	1739	99	89	79	20
			Citrus clean	1808	98	85	75	38
2	Seminar Hall Non AC	25	Nature Pure	450	100	60	49	16
			Citrus clean	519	100	77	38	12
3	Library	35	Nature Pure	2679	87	76	63	44
			Citrus clean	2188	86	81	65	42
4	Health care center	15	Nature Pure	640	76	47	15	6
			Citrus clean	590	78	42	19	4
5	Auditorium AC	30	Nature Pure	260	85	54	15	8
			Citrus clean	360	94	67	28	17
Average			Nature Pure	1442	89.4			
			Citrus clean	1296	91			

Fungal aerosol

The biocidal activity of **ODONIL Citrus clean** on fungal aerosol is 56% within 30 mins. Similarly, **ODONIL Nature pure** is 46 % within 30 mins. (table 6). The results reveals that the biocidal activity of citrus clean is efficient (56 %) than Nature pure (46%) on fungal aerosol in indoor environmental conditions (table. 6).

Table 6: Percent efficiency of Nature pure and Citrus Clean Spray on fungal aerosol at sampling sites

Sr. No	Sampling Site	No.Spray	Test chemical	Before spray CFU/m^3	% Reduction of fungal aerosol After spray of 30mins
1	Toilets	10	Nature Pure	180	50
			Citrus clean	120	58
2	Seminar Hall Non AC	25	Nature Pure	300	50
			Citrus clean	290	72
3	Library	35	Nature Pure	2298	35
			Citrus clean	2348	32
4	Health care center	15	Nature Pure	1998	40
			Citrus clean	1898	47
5	Auditorium AC	30	Nature Pure	180	44
			Citrus clean	190	53

According to recommended dose of ODONIL aerosol spray for different indoor environment prescribed by National building code of India, 2016 for an Auditorium with 1000 seats (Room dimension 540ftX 653 ft) require 211ml of air sanitizer and for living room (room dimension 12ftX 18ft) 1.2 ml is required for satisfactory sanitization. Thus (Table 7) overall all Efficiency of Odonil air sanitizer Nature pure is 56 % after 60min similarly overall all Efficiency of Odonil air sanitizer citrus clean is 59 % after 60min. From this it is evident that both the formulation of Odonil Air sanitizer keep check on bioaerosol load in air after 60min.

Conclusion and Recommendations

Dabur India Pvt Ltd. has formulated two aerosol spray-Odonil Nature pure and Odonil Citrus clean. The Efficacy study of these two aerosol sprays were carried out as per the methods prescribed by USEPA (1980) at normal indoor conditions. The result obtained from the study reveals that, the Odonil aerosol spray-Nature pure and Citrus clean are recorded to be efficient in its biocidal activity against the bioaerosols.

Because overall biocidal activity of ODONIL aerosol spray- Nature pure is 91% within 10 minutes of its spray. The biocidal efficiency decreased after 20, 40 and 60 minutes to 68%, 46% 18% respectively. Similarly, the efficiency of ODONIL aerosol spray- Citrus clean is 93 % within 10 minutes of its spray. The biocidal efficiency decreased after 20, 40 and 60 minutes to 72%, 49% 23% respectively. On an average, the biocidal activity of citrus clean is better in its efficiency (59 %) than Nature pure (56%) during first hour of spray may be due to presence of Pine Oil which shows slightly higher killing activity.

Both the aerosol spray is initially very effective for the first 10minutes after spraying and both the sprays were effective in significantly reducing the bacterial and fungal load in air instantly.

The perfume used for the aerosol spray are made up of essential oils/ synthetic perfumes and used Butalated hydroxy toluene(BHT) is used as preservatives against rancidity of perfumes. The Tri-ethylene glycol and isopropyl Alcohol are used for antibacterial activity of the aerosol spray. And Deodorized LPG is used for aerosolization of the air sanitizer

The major constituent of Odonil air sanitizer spray is Triethylene glycol(TEG). TEG has a germicidal property used for disinfection of air to remove Meningo-pneumonitis virus or Psittacosis virus.(Rosebury *et al.,* 1947). TEG is also effective fungicide and bactericidal in nature (Ward, 1956) The Odonil Citrus clean formulation include Pine oil which also exhibit antimicrobial activity and proven to be used as disinfectant in the form of distillate product emulsion (Shippen & Griffin, 1921). Lastly the both the Odonil formulation also contains Isopropyl alcohol. According to WHO guidelines Isopropyl alcohol induces protein disintegration of microorganisms and bring about killing effect. Thus the formulation contain three major ingredients which give combined effect to resist bioaerosol load in indoor public spaces.

The antimicrobial sensitivity test on ODONIL aerosol spray – Nature pure and Citrus clean was found to be 100 % sensitive against Staphylococcus aureus, E. coli and Salmonella typhi. The inhibitory activity of the aerosol spray is due to the volatile properties and its chemical composition. The overall study finds that ODONIL aerosol spray is efficient in its biocidal activity against airborne microbes in indoor environment. The efficiency rate depends upon the aerosol application methods, quantity, microbial load and indoor environmental conditions such as relative humidity, temperatures and ventilation.

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