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Impact of Houseplants on Sound Level in Residential Buildings

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Abstract Plants absorb, diffract and reflect sound. The balance varies with the frequency at which the sound is generated and the room's physical properties. For the study, drawing rooms and dining living rooms of the 10 west facing residential buildings along with the National Highway- 8 in polluted zone, was analyzed through its physical, chemical and other characteristics. Four varieties of foliage and succulent plants were kept in one, two or four suitable corners with four different habits, viz., Opened and Closed windows and fan in On and Off mode.To find out the existing IES, all the experiments were done without any houseplants on day 1 in selected rooms. The houseplants were kept on day 2 to judge the impact of houseplants on IES and again houseplants were removed on day 3 to know the retention of impact of houseplants on air quality. On the basis of results, succulent plants are advisable to accoust the sound disturbances.

Keywords Houseplants, Sound level, Residential Buildings, Decibles (dB).

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Introduction

Though the first plants appeared on land only about half a billion years ago, today they account for by the largest proportion of the earth's biomass. Their beauty, fragrance and amazing traits fascinate and bring intellectual and aesthetic pleasure to many humans. There is nothing more lovely and cheery than a room filled with beautiful green plants. Bringing the outdoors in, has always been a challenge. Plants were meant to grow outside, under natural conditions, not under an artificial environment inside. The Victorians were the first ones to attempt bringing their favorite plants indoors. More important reason plants are being brought indoors today, has not so much to do with beauty, as it does with health (http://studyres.com/doc/1145640/session-2-reading).

Plants have many known benefits to their environments and the people in them, but noise reduction is one of the less-known advantages. Plants absorb, diffract and reflect sound. The balance varies with the frequency at which the sound is generated and the room's physical properties. The type of plant, its size, shape, the container, top dressings and the compost, all have an effect on the sound reduction capabilities of plant displays. Plant parts such as stems, leaves, branches and wood all absorb sound. Rough bark and thick, fleshy leaves are particularly effective at absorbing sound with their dynamic surface area. The greater number of plants, the size of the plant and its surface area will all affect its ability to absorb sound. Plants alter room acoustics by reducing the reverberation time. They tend to work better in acoustically live spaces, such as those that have hard sur-

Table 1. Comparative mean sound level (in dB) in selected rooms according to habits and number of foliage plants. Day 1- Existing Sound Level without any Houseplant. Day 2- Sound Level after keeping the Houseplant/s. Day 3- Sound Level after removal of the Houseplant/s. ↓-denotes decrease in Sound Level (Sound level of Day 2 was subtracted from the Sound level of Day 1). -↑ denotes increase in Sound Level (Sound level of Day 3 was subtracted from the Sound level of Day 2).

Types of houseplants	Foliage plant											
No. of houseplants	One foliage plant						Two foliage plants					
Rooms	Drawing room			Dining/Living room			Drawing room			Dining/Living room		
Days	1	2	3	1	2	3	1	2	3	1	2	3
Habits												
Opened windows	62.93	58.73	61.54	60.23	55.87	59.03	60.23	53.79	59.03	62.18	57.57	60.54
		↓4.2	↑2.81		↓4.36	↑3.16		↓6.44	↑5.24		↓4.61	↑2.97
Closed windows	64.54	60.43	64.20	66.21	60.24	65.64	64.51	58.90	65.27	68.38	60.88	66.67
		↓4.11	↑3.77		↓5.97	↑ 5.4		↓5.61	↑6.37		↓7.5	↑5.79
Fan On	60.74	55.46	59.65	59.55	54.13	57.68	59.55	52.93	58.22	59.62	53.16	58.06
		↓5.28	↑4.19		↓5.42	↑3.55		↓6.62	↑5.29		↓6.46	↑4.90
Fan Off	62.93	58.43	61.54	62.18	59.27	60.54	60.23	54.26	59.03	60.23	54.90	59.03
		↓4.5	↑3.11		↓2.91	↑1.27		↓5.97	↑4.77		↓5.83	↑4.63

Table 1. Continued.

Types of houseplants	Foliage plants					
No. of houseplants	Four foliage plants					
Rooms	Drawing room			Dining/Living room		
Days	1	2	3	1	2	3
Habits						
Opened windows	59.87	51.48	58.47	59.87	53.48	58.47
		↓8.39	↑6.99		↓6.39	↑4.99
Closed windows	65.28	59.82	63.99	68.45	64.48	66.97
		↓5.46	↑4.17		↓3.97	↑2.49
Fan On	60.74	54.73	59.55	59.47	53.07	57.92
		↓ 6.01	↑4.82		↓ 6.67	↑4.85
Fan Off	59.87	52.88	58.47	59.87	56.88	58.47
		↓6.99	↑5.59		↓2.99	↑1.59

faces like marble walls, exposed concrete and stone floors. The impact of plants is less likely to be noticeable in an acoustically quiet space, containing soft furnishings, carpets, heavy curtains or well upholstered chairs, which have a much greater capacity to absorb sound (Kenneth 2014).

Materials and Methods

Research design

To achieve the planned objectives the present study was carried out by using experimental research design. The zone selected as sample for the purpose of the present study falls under the polluted zone as per the U.I.T, Udaipur. In this polluted zone, there were 15 west facing houses along with the National Highway- 8 in Udaipur. This houses were constructed by Rajasthan Housing Board (RHB). Out of these 15 houses, 10 houses were selected purposively for conducting all the experiments. The drawing and living/ dining rooms of the ten residences selected as sample were purposively utilized for conducting all the experiments. In order to be precise in measuring the impact of houseplants on room temperature in residences considering the following 4 parameters, viz., Variation in houseplants, Placement of houseplants, Variation in days and Variation in habits.

Table 2. Comparative mean sound level (in dB) in selected rooms according to habits and number of succulent plants. Day 1- Existing Sound Level without any Houseplant. Day 2- Sound Level after keeping the Houseplant/s. Day 3. Sound Level after removal of the Houseplant/s. ↓ denotes decrease in Sound Level (Sound level of Day 2 was subtracted from the Sound level of Day 1). ↑-denotes increase in Sound Level (Sound level of Day 3 was subtracted from the Sound level of Day 2).

Type of houseplants	Succulent houseplants											
No. of houseplants	One succulent plant						Two succulent plants					
Rooms	Drawing room			Dining/Living room			Drawing room			Dining/Living room		
Days	1	2	3	1	2	3	1	2	3	1	2	3
Habits												
Opened windows	63.98	58.58 ↓5.4	62.65 ↑4.07	63.98	59.88 ↓4.1	62.65 ↑2.77	57.74	51.02 ↓ 6.72	56.67 ↑5.65	58.14	53.33 ↓4.81	57.39 ↑4.06
Closed windows	66.70	61.88 ↓4.82	66.46 ↑3.47	66.88	61.33 ↓5.55	66.52 ↑5.19	69.30	63.80 ↓5.5	68.26 ↑4.46	67.59	61.94 ↓5.65	66.54 ↑4.6
Fan On	60.18	56.19 ↓3.99	59.09 ↑2.9	59.62	54.83 ↓4.79	57.60 ↑2.77	59.80	54.59 ↓5.21	58.29 ↑3.7	59.66	53.98 ↓5.68	58.10 ↑4.12
Fan Off	62.65	59.38 ↓3.27	67.68 ↑2.3	58.47	56.41 ↓2.06	57.49 ↑1.08	57.74	52.92 ↓4.82	56.67 ↑3.75	63.98	59.58 ↓ 4.4	62.65 ↑3.07

Table 2. Continued.

Type of houseplants	Succulent houseplants					
No. of houseplants	Four succulent plants					
Rooms	Drawing room			Dining/Living room		
Days	1	2	3	1	2	3
Habits						
Opened windows	63.25	55.89 ↓7.36	61.50 ↑5.61	63.25	55.39 ↓7.86	60.90 ↑5.51
Closed windows	69.30	61.54 ↓7.76	67.34 ↑5.8	68.55	61.55 ↓7.00	66.50 ↑4.93
Fan On	59.21	52.16 ↓6.96	57.35 ↑5.19	59.62	52.40 ↓7.22	57.71 ↑5.31
Fan Off	67.72	60.88 ↓6.84	65.46 ↑4.58	64.04	57.33 ↓6.71	62.4 ↑5.07

Variation in houseplants

The two most common types of houseplants, i.e., foliage and succulent plants had been purposively selected. The varieties of these two types of houseplants are as under : Type 1 : Foliage Plants- Leafy plants grown for their broad, green/colored leaves. Varieties of foliage houseplants selected for the experiment were : Alocasia *(Alocasia indica),* Syngonium *(Syngonium podophyllum),* Money-plant *(Scindapsus arboricola),* Dumb cane *(Dieffenbachia amoena).* Type 2: Succulents - Evergreen attractive plants with fleshy leaves. Varieties of succulents selected for the research were : Kalanchoe *(Klanchoe pinnata),*Mother inlaw's tongue *(Sansevieria trifasciata 'Laurentii'),* Devil's backbone *(Pedilanthus tithyloides),* Boat Lily *(Rhoeo spathacea).*

Placement of houseplants :

Potted houseplants were placed in the following manner : Single potted plant in one suitable corner of the room. Two single potted plants in two suitable corners of the room. Four single potted plants in four corners of the room.

Variation in days

The time required for conducting each experiment was 3 days. Day 1 *(Pre test)* - Before placing the houseplants, to find out the existing status of room temperatures. Day 2 (Post test) - Keeping the selected number of houseplants in selected rooms in the residences to judge the impact of houseplants on room temperatures. Day 3 (Post test for retention) – After removal of houseplants to identify the retention of changed room temperatures, if any.

Variation in habits

People generally live with the following practices in their houses, so the same practices were included in the variations for conducting the experiments : 1. Opened and Closed windows. 2. Fan in On and Off mode.

Conducting the experiments

To avoid ambiguity in data collection the experiments were conducted in the month of April and May, when the atmospheric ambient temperature was maximum. All the readings were taken on day 1, day 2 and day 3 at 3:00 PM. On day 2 houseplants were kept at 10:00 AM. On day 3 houseplants were removed at 10:00AM. Thus the duration of keeping houseplant/s was 24 h.

Analysis of data

Data were collected, tabulated and analyzed through coding, tabulation. Arithmetic mean, Standard Deviation, Analysis of variance and Paired-*t* test.

Results and Discussion

The sources of noise in a residential building can be generated by radio, television, rock music with high volume, household equipment. The Environmental Protection Agency (EPA)addressed 35 dB 45 dB as the recommended limit of sound level in indoors. Noise exposure reduction in homes may be achieved by the application of engineering control techniques such as alteration of design or construction of sound barriers and sound absorbers. Other method to control noise can be the regulation of exposed personnel such as use of ear protective device. Both these methods are usually expensive (Encyclopedia of ecology and environment, vol. 1). In the year 2010, it was mentioned in a website that houseplants serve as wonderful barriers to noise. It has known for years that plantings in residential buildings absorb large amounts of noise, making for a better quality of life for the residents(http://www.mcjags.com/rog.greenspaces.html). Hence, the experiments were conducted to know the impact of houseplants in reducing the sound level. This technique is not only environment friendly but also improves the indoor environment aesthetically. The results during the experimentation to judge the impact of houseplants on IAQ by reducing the sound level, are elucidated in the Tables 1 and 2. The remarkable difference was observed after keeping houseplants through decreased means under various subparameters selected for the purpose of the study.

Impact of types of houseplants on sound level

Foliage v/s succulent plants

Sound waves in the air was more accousted by the succulent plants as compared to foliage plants. Under the condition of keeping four foliage plants in drawing room with closed windows the sound level was decreased from 65.28 dB to 59.82 dB, i.e., a fall of 5.46 dB was observed, while a decline of 7.76 dB from 69.30 dB to 61.54 db by succulent plants was examined during the analysis of data. The findings persuade the common people to utilize the accoustic quality of houseplants by keeping them indoors for a comfortable IES with least of sound disturbances.

Impact of number and placements of houseplants on sound level

The increasing the number of houseplants certainly helped in absorbing greater decibles of noise. In drawing room one succulent plant with opened windows absorbed the sound level up to 4.1 dB. Likewise, two succulents were able to absorb 4.81 dB of sound and

Table 3. ANOVA values of sound level (in dB) in selected rooms according to habits and number of houseplants. *Significant at 5% level of significance.

Type of houseplants	Foliage houseplants					
No.of houseplants	One foliage plant		Two foliage plants		Four foliage plants	
Rooms	Drawing room	Dining/Living room	Drawing room	Dining/Living room	Drawing room	Dining/Living room
Habits						
Opened windows	1.34^{NS}	3.37*	8.95*	1.53^{NS}	0.21*	5.34*
Closed windows	1.39^{NS}	3.32^{NS}	2.57^{NS}	4.08*	2.21^{NS}	1.02^{NS}
Fan On	7.96*	6.13*	10.05*	9.10*	9.59*	12.09*
Fan Off	1.46^{NS}	0.62^{NS}	6.39*	6.03*	7.65*	1.09^{NS}
Type of houseplants						
No. of houseplants	One succulent plant		Two succulent plants		Four succulent plants	
Rooms	Drawing room	Dining/Living room	Drawing room	Dining/Living room	Drawing room	Dining/Living room
Habits						
Opened windows	3.74*	1.96^{NS}	12.24*	7.67*	3.06^{NS}	3.31^{NS}
Closed windows	1.74^{NS}	2.31^{NS}	2.43^{NS}	1.11^{NS}	4.61*	2.51^{NS}
Fan On	2.47^{NS}	6.04*	6.73*	8.21*	18.29*	17.08*
Fan Off	1.14^{NS}	1.16^{NS}	8.12*	2.22^{NS}	6.03*	2.42^{NS}

four succulents absorbed 7.86 dB of sound. Thus, the data is eloquent that more the number of houseplants used in a building greater will be the absorbing level of sound resulting into better IES.

Impact of houseplants on sound level with variations in days

Under all the conditions and variations the existing sound level measurement was accounted on day one without any houseplant. The sound level decreased after keeping one, two or four foliage/succulent plants on day two and again sound level went up on day three after the removal of houseplant's. One example accounts like this that the existing average sound level reading was 62.93 dB on day one, which was reduced to 58.43 dB, i.e., a fall up to 4.52 dB on day two after keeping one foliage plant in drawing room with fan On condition. After the removal of houseplant, the sound level again reached near about the day one's measurement, i.e., 61.54 dB with an increase in sound level up to 3.11 dB.

Impact of houseplants on sound level with variations in habits

Opened windows v/s Closed windows

One succulent plants was found to be more impressive with a decrease in sound level up to 5.4 dB and 4.82 dB in opened and closed windows, respectively. Whereas the one foliage plant was able to absorb only 4.2 dB of sound in opened windows and 4.11 dB in closed windows.

Fan on v/s Fan off

The four succulent plants in drawing room were found to be more accoustic in absorbing the noise infan On condition by reducing sound level up to 6.96 dB as compared to foliage plants with a reduction of 6.01 dB of sound (tables 4.24 (A) and 4.24 (B). On the other hand, four foliage plants were better in absorbing the noise in fan Off condition by decreasing the sound level up to 6.99 dB as compared to four succulent plants with a reduction of 6.84 dB. So, it can be assumed that the thick leaves of succulent plants worked as an accoustic agent for the residential indoors.

Impact of selected rooms of residences

Houseplants were able to reduce the sound level in both the areas of sample residences, selected for the purpose of the study.

Statistical analysis of data

It is shown in the Table 3 that there was non signifi-

Table 4. Paired-t values of sound level (in dB) in selected rooms according to habits and number of houseplants. ^{NS} Non Significant. * Significant at 5% level of significance. **Significant at 1% level of significance. D_1-D_2–Difference in sound level between day 1 and day 2. D_2-D_3–Difference in sound level between day 2 and day 3.

Type of houseplants	Foliage plants							
No. of houseplants	One foliage plant				Two foliage plants			
Rooms	Drawing room		Dining/Living room		Drawing room		Dining/Living room	
Days	D_1–D_2	D_2–D_3	D_1–D_2	D_2–D_3	D_1–D_2	D_2–D_3	D_1–D_2	D_2–D_3
Habits								
Opened windows	9.88**	7.45**	7.96**	5.74**	2.56*	11.36**	10.4**	7.71**
Closed windows	6.96**	7.54**	12.78**	10.82**	7.51**	5.29**	16.86**	0.20^{NS}
Fan On	16.60**	13.52**	10.44**	8.24**	13.45**	11.33**	13.13**	10.23**
Fan Off	9.66**	10.99**	7.69**	5.27**	13.15**	8.88**	10.49**	6.12**
Type of houseplants	Succulent plants							
No. of houseplants	One succulent plant				Two succulent plants			
Rooms	Drawing room		Dining/Living room		Drawing room		Dining/Living room	
Days	D_1–D_2	D_2–D_3	D_1–D_2	D_2–D_3	D_1–D_2	D_2–D_3	D_1–D_2	D_2–D_3
Habits								
Opened windows	17.14**	9.95**	12.39**	8.39**	23.09**	21.08**	23.24**	3.78**
Closed windows	10.06**	13.67**	10.40**	11.46**	21.48**	15.38**	16.82**	14.46**
Fan On	9.28**	7.45**	10.24**	5.39**	12.71**	4.99**	13.82**	6.09**
Fan Off	9.45**	8.68**	30.03**	2.55*	7.54**	5.07**	1.77^{NS}	18.38**

Table 4. Continued.

Type of houseplants	Foliage plants			
No. of houseplants	Four foliage plants			
Rooms	Drawing room		Dining/Living room	
Days	D_1–D_2	D_2–D_3	D_1–D_2	D_2–D_3
Habits				
Opened windows	13.36**	9.64**	12.41**	4.79**
Closed windows	13.42**	8.31**	12.64**	6.55**
Fan On	27.32**	13.62**	17.78**	12.89**
Fan Off	20.99**	13.40**	9.49**	5.25**
Type of houseplant	Foliage plants			
No. of houseplants	Four succulent plants			
Rooms	Drawing room		Dining/Living room	
Days	D_1–D_2	D_2–D_3	D_1–D_2	D_2–D_3
Habits				
Opened windows	17.04**	13.72**	21.13**	15.48**
Closed windows	23.03**	14.98**	17.69**	9.94**
Fan On	23.11**	17.96**	12.78**	10.71**
Fan Off	13.31**	10.85**	21.86**	13.24**

cant difference in ANOVA values, under almost half of the selected subparameters but there is a difference which proves the effectiveness of houseplants in improving the IAQ with special reference to reduce the sound level in the indoor air. It is clearly represented in Table 4 that there was significant difference in paired-*t* values except few, between day one (without any houseplant) and day two (after keeping the houseplant/s), and day two and day three (after removal of housplant/s) which again confirms the capability of houseplants in decreasing the sound level in indoor air, thus improving the IES. The impact of houseplants in reducing the sound level has also comr out in the standard deviations. So, for the accoustical effect houseplants are efficient in improving the IES by absorbing the disturbing noises from the environment, making the indoors more comfortable and livable.

Conclusion

Sound waves in the air were more accousted by the

succulent plants as compared to foliage plants. The increment in hoseplants certainly helped in absorbing greater decibles of noise. The sound level decreased after keeping one, two or four foliage/succulent plants on day two and again sound level went up on day three after the removal of houseplant/s. Succulent plants again found to be more impressive in reducing the sound level ascompared to foliage plants in Opened windows, Closed windows and with fan in On sitution; while foliage plants were great in reducing the sound level with fan in Off condition. Thus, the houseplants are effective in improving the IAQ with special reference to reduction in noise level indoors.

References

Encyclopedia of ecology and environment, vol. 1.

http://studyres.com/doc/1145640/session-2-reading, cited on 12.02.2018.

http://www.mcjags.com/rog.greenspaces.html, 2010.

Kenneth Freeman (2014) How plants can reduce noise levels indoors. Blog cited from : http:www.huffingtonpost.co.uk/kenneth-freeman/how-plants-can-reduce-noi_b_4802876.html