

# Improving indoor oxygen in residential buildings using houseplants

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■ **ABSTRACT** : Cities need more trees and plants. People are getting tired of cities without them. They want pretty flora that will attract fauna. Plants growing should be made a legal commitment for industries as well as household level. Everyone should involve and encourage population, to generate love for the plants and trees. Cool greenery pleases the human eye and soothes the mind. Moreover, the cleansing of the environment needs the planting of trees, shrubs and plants as these replenish oxygen in the atmosphere, so essential for human life. Though it is not possible for everyone to plan something for global environment, but small contributions should definitely be made by individuals. So, the study was carried out to aware the people that plants help in maintaining the purity of indoor environmental status by enhancing the oxygen level. Results entailed that houseplants performed their best, whenever they were utilized, either indoor or outdoor by releasing O<sub>2</sub> and making the IAQ fresh and pure. However, plants perform better in enclosed and air tight chambers, as the rooms without any ventilation require fresh air, which plants do by releasing O<sub>2</sub>.

■ **KEY WORDS**: Houseplants, Indoor environmental status (IES), Oxygen concentration

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Plants provide oxygen. In their process of photosynthesis, they take in carbon dioxide, using it to make the sugars they need to supply them with energy. In turn, they release oxygen as a by-product of that process. This is how the living biota gets the oxygen that we all breathe. The more green spaces people have, the more oxygen produced for their benefit. As the processes of photosynthesis are carried out, other chemical substances are absorbed into the leaves of plants. The plants have a mechanism for breaking down these chemicals to use the beneficial ones for their processes. This help to filter pollutants from the air that we breathe (Evelyn, 2006).

It has been proved that plants absorb toxins produced by modern furnishing materials. In addition to this, the carbon dioxide gas exhaled by people is filtered into the centre of the building, where the plants absorb this and produce oxygenated air, which is then filtered back. Thus, the air indoors seems pure ([http://www.mcjags.com/rog/greens\\_paces.html](http://www.mcjags.com/rog/greens_paces.html),

2006).

The houseplants are the latest word in household cleaning. Research now shows that houseplants play an important role in cleaning the air, both indoors and outdoors. Plants produce their own food through a process called photosynthesis. This means they take in carbon dioxide from the atmosphere and release oxygen. Photosynthesis “cleans” our air by absorbing carbon dioxide and by taking in certain other pollutants, as well. Until recently, indoor air pollution was not considered a health threat; most homes and public buildings leaked so much that air often was replaced every couple of hours. In closed buildings, indoor air might linger for five hours or more allowing pollutants to accumulate. Researchers are just beginning to understand how indoor pollutants such as cigarette smoke can harm humans. Houseplants proved effective in removing certain indoor air pollutants. Plants have many useful qualities, including one of making indoor air cleaner to breath (Pottorff, 2006).

To a certain extent, all plants can replenish oxygen levels while reducing carbon dioxide (and low levels of carbon monoxide) through the process of photosynthesis. However, some plants are more effective at reducing air pollutants than others. To keep the air in home clean, start with easy-to-grow favourites. If one keeps them healthy and beautiful, in no time at all they'll reward with fresh, unpolluted air-for free! (Schemp, 2000).

In order to find out the impact of houseplants on oxygen concentration and ultimately improving the indoor environmental status, the study was done with the following objectives:

- To compare the utilization of foliage and succulent houseplants in enhancing the oxygen level.
- To study the impact of houseplants in increasing the oxygen level in various areas of the residences.

## ■ RESEARCH METHODS

To achieve the planned objectives the present study was carried out by using pre- post test 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. These houses were constructed by Rajasthan Housing Board. Out of these 15 houses, 10 houses were selected purposively for conducting all the experiments. The drawing and living/dining rooms of the 10 residences selected as sample were purposively utilized for conducting all the experiments.

In order to be precise in measuring the impact of houseplants on SPM in residences the following parameters were considered:

- Variation in houseplants
- Placement of houseplants
- Variation in days
- Variation in habits

### Variation in houseplants :

The two most common types of houseplants, *i.e.*, foliage and succulent plants were purposively selected. The varieties of these two types of houseplants were as : *Foliage plants*- Leafy plants grown for their broad, green/ coloured leaves. Varieties of foliage houseplants selected for the experiment were, Alocasia, Syngonium, Money-plant, Dumb cane. *Succulents*- Evergreen attractive plants with fleshy leaves. Varieties of succulents selected for the research were, Kalanchoe, Mother in-law's tongue, Devil's backbone, Boat lily.

### Placement of houseplants :

1, 2 or 4 potted houseplants were placed at one, two or four suitable 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 oxygen concentration. Day 2 (Post-test) - Keeping the selected number of houseplants in selected rooms in the residences to judge the impact of houseplants on oxygen concentration. Day 3 (Post test for retention) - After removal of houseplants to identify the retention of changed oxygen concentration, 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 following measures were taken:

- The readings of oxygen level were taken through the equipment of BW technologies, Gas Alert Micro 5 PID.
- 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 10:00 AM.
- The data were collected with performance of daily routine activities such as normal living conditions, dusting, brooming and mopping.

### Analysis of data :

To study the role of houseplants in improving the oxygen concentration in indoors, arithmetic mean and paired t-test were applied.

## ■ RESEARCH FINDINGS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

### Impact of houseplants on oxygen content in residential buildings :

Oxygen is an element which is essential for breathing. It is colourless, odourless gas that is the most abundant element, forms compounds with most others, and is essential for plant and animal respiration. Diatomic oxygen (O<sub>2</sub>) is one of the two major components of air (20.95%). It is produced by plants during photosynthesis, and is necessary for aerobic respiration in animals. Houseplants produce the oxygen and are the best for improving the indoor air quality. It depends on the health of the plant, its size, and the light levels where it is

growing. In general, more light means more photosynthesis and more oxygen production.

It is reflected from the findings of Tables 1 and 2 that utilizing the houseplants in residential buildings resulted into a great impact in improving the IES especially through enhancing the O<sub>2</sub> in indoor air. The comparative mean differences in O<sub>2</sub> enhancement while performing the experiments under various selected sub-parameters to judge the impact of houseplants are shown in Tables 1 and 2. The impact of houseplants on O<sub>2</sub> has been discussed under the following heads:

**Impact of types of houseplants on oxygen level :**

*Foliage v/s succulent plants :*

According to Tables 1 and 2, the foliage plants were found to be more efficient under all the variations selected for the purpose of the study, in enhancing the O<sub>2</sub> in indoor air of selected areas of the residential buildings.

It is observable from the table that one foliage plant was able to release more O<sub>2</sub> (0.12%) as compared to one succulent plant (0.10%) in drawing room with opened windows. Similar difference can be seen in all the sub-parameters. Though, the succulent plants also helped in O<sub>2</sub> increment as per the

**Table 1 : Comparative mean oxygen level (in %) in selected rooms according to habits and number of foliage plants**

Types of houseplants	Foliage plants																	
	One foliage plant						Two foliage plants						Four foliage plants					
No. of houseplants	Drawing room			Dining/living room			Drawing room			Dining/living room			Drawing room			Dining/living room		
Rooms	Drawing room			Dining/living room			Drawing room			Dining/living room			Drawing room			Dining/living room		
Days	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Habits																		
Opened windows	20.65	20.77	20.67	20.65	20.81	20.68	20.64	20.79	20.67	20.65	20.78	20.66	20.64	20.79	20.70	20.64	20.78	20.73
		↑0.12	↓0.10		↑0.16	↓0.13		↑0.15	↓0.12		↑0.13	↓0.12		↑0.15	↓0.06		↑0.14	↓0.09
Closed windows	20.64	20.74	20.67	20.65	20.77	20.67	20.63	20.76	20.67	20.64	20.76	20.67	20.65	20.77	20.67	20.64	20.77	20.67
		↑0.10	↓0.13		↑0.12	↓0.10		↑0.13	↓0.09		↑0.12	↓0.09		↑0.12	↓0.10		↑0.13	↓0.10
Fan "ON"	20.65	20.72	20.68	20.66	20.73	20.69	20.66	20.77	20.68	20.66	20.77	20.69	20.66	20.77	20.68	20.67	20.78	20.68
		↑0.29	↓0.21		↑0.07	↓0.04		↑0.11	↓0.09		↑0.11	↓0.08		↑0.11	↓0.09		↑0.11	↓0.10
Fan "OFF"	20.65	20.77	20.67	20.65	20.77	20.67	20.64	20.77	20.67	20.65	20.8	20.68	20.65	20.81	20.68	20.64	20.79	20.73
		↑0.12	↓0.10		↑0.12	↓0.10		↑0.13	↓0.10		↑0.15	↓0.12		↑0.16	↓0.13		↑0.15	↓0.06

Days- Day 1- Existing oxygen level without any houseplant.  
 Day 2- Oxygen level after keeping the houseplant/s.  
 Day 3- Oxygen level after removal the houseplant/s.  
 Arrows- ↑- Denotes increase in oxygen level.  
 ↓- Denotes decrease in oxygen level.

**Table 2 : Comparative mean oxygen level (in %) in selected rooms according to habits and number of succulent plants**

Types of houseplants	Succulent plants																	
	One succulent plant						Two succulent plants						Four succulent plants					
No. of houseplants	Drawing room			Dining/living room			Drawing room			Dining/living room			Drawing room			Dining/living room		
Rooms	Drawing room			Dining/living room			Drawing room			Dining/living room			Drawing room			Dining/living room		
Days	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Habits																		
Opened windows	20.63	20.73	20.67	20.66	20.77	20.7	20.65	20.76	20.69	20.63	20.74	20.67	20.63	20.74	20.67	20.65	20.74	20.67
		↑0.10	↓0.06		↑0.11	↓0.07		↑0.11	↓0.07		↑0.11	↓0.07		↑0.09	↓0.07		↑0.09	↓0.07
Closed windows	20.62	20.72	20.62	20.64	20.7	20.62	20.62	20.72	20.63	20.64	20.74	20.65	20.64	20.77	20.66	20.62	20.74	20.66
		↑0.10	↓0.10		↑0.06	↓0.08		↑0.10	↓0.09		↑0.10	↓0.09		↑0.13	↓0.11		↑0.12	↓0.08
Fan "ON"	20.66	20.78	20.69	20.67	20.78	20.68	20.66	20.77	20.67	20.67	20.78	20.68	20.67	20.81	20.67	20.67	20.8	20.67
		↑0.12	↓0.09		↑0.11	↓0.10		↑0.11	↓0.10		↑0.11	↓0.1		↑0.14	↓0.14		↑0.13	↓0.13
Fan "OFF"	20.63	20.75	20.67	20.63	20.74	20.67	20.65	20.71	20.69	20.66	20.72	20.7	20.65	20.74	20.67	20.66	20.75	20.67
		↑0.12	↓0.08		↑0.11	↓0.07		↑0.06	↓0.02		↑0.06	↓0.02		↑0.09	↓0.07		↑0.09	↓0.08

Days- Day 1- Existing oxygen level without any houseplant.  
 Day 2- Oxygen level after keeping the houseplant/s.  
 Day 3- Oxygen level after removal the houseplant/s.  
 Arrows- ↑- Denotes increase in oxygen level.  
 ↓- Denotes decrease in oxygen level.

composition of the air, but the performance was observed to be more significant in case of foliage plants. Hence, it is judged that both types of houseplants could be kept indoors for fresh indoor air.

**Impact of number and placements of houseplants on oxygen level :**

It is apparent from Tables 1 and 2 that as the number of houseplants increased the average mean difference in O<sub>2</sub> enhancement also increased. Tables entail that one foliage plant in dining/ living room with fan OFF condition helped in increasing O<sub>2</sub> in indoor air from 20.65 per cent to 20.77 per cent that is an increment up to 0.12 per cent was observed. Likewise two foliage plants helped in increasing O<sub>2</sub> up to 0.13 per cent and four foliage plants helped in enhancing O<sub>2</sub> up to 0.16 per cent in indoor air under the similar circumstances.

**Impact of houseplants on oxygen level with variations in days:**

The existing average oxygen level reading was 20.65 per cent on day one, which was increased to 20.77 per cent, *i.e.*, an increment up to 0.12 per cent on day two after keeping one foliage plant in dining/ living room with closed windows. After the removal of houseplant, the oxygen level again reached near about the day one’s measurement, *i.e.*, 20.67 per cent with a decrease of 0.10 per cent of oxygen content in the air.

**Impact of houseplants on oxygen level with variations in habits:**

Habits generally used by the common people are

windows opened or closed and fan ON and OFF condition. The impact of houseplants with above habits can be revealed from Tables 1 and 2.

*Opened windows v/s closed windows :*

As mentioned in Tables 1 and 2 that one foliage plant in dining / living room proved to be more effective in increasing O<sub>2</sub>, *i.e.*, 0.16 per cent and 0.12 per cent, respectively with these two habits. Though the one succulent plant also helped in increasing O<sub>2</sub> content up to 0.11 per cent and 0.06 per cent under the similar conditions but the contribution was comparatively lower than the foliage plants.

*Fan on v/s fan off condition :*

It was noticeable from Tables 1 and 2 that one foliage plant was good at increasing O<sub>2</sub> in fan OFF mode (0.12 %) as compared to succulent plants (0.11 %). While succulent plants performed well in fan ON mode (0.11 %) in comparison to foliage plants (0.07 %).

**Impact of houseplants on oxygen level in selected rooms of residences :**

It is accentuated from the research presented in Tables 1 and 2 that houseplants definitely helped in O<sub>2</sub> enhancement in both the selected areas of the residential buildings.

**Statistical analysis of data :**

It is clearly depicted in Table 3 that there was significant difference in most of the paired-t values, between day one

Table 3 : Paired- t values oxygen level (in %) in selected rooms according to habits and number of houseplants													
Type of houseplants	Foliage plants												
Number 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		
Days	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	
Habits													
Opened windows	2.00 <sup>NS</sup>	6.76*	1.45 <sup>NS</sup>	1.16 <sup>NS</sup>	9.38*	9.23*	2.03 <sup>NS</sup>	5.18*	6.69*	3.91*	8.75*	1.09 <sup>NS</sup>	
Closed windows	4.76*	0.61 <sup>NS</sup>	2.00 <sup>NS</sup>	4.76*	2.00 <sup>NS</sup>	0.73 <sup>NS</sup>	2.00 <sup>NS</sup>	0.73 <sup>NS</sup>	2.00 <sup>NS</sup>	6.76*	2.03 <sup>NS</sup>	4.76*	
Fan “ON”	4.66*	2.50**	1.09 <sup>NS</sup>	0.158 <sup>NS</sup>	4.78*	3.00**	6.14*	3.20**	4.78*	3.91*	6.14*	4.76*	
Fan “OFF”	2.00 <sup>NS</sup>	6.76*	2.00 <sup>NS</sup>	6.76*	1.16 <sup>NS</sup>	0 <sup>NS</sup>	9.38*	9.23*	8.75*	2.03 <sup>NS</sup>	6.69*	3.20**	
Type of houseplants													
Succulent plants													
Number 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		
Days	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	D <sub>1</sub> -D <sub>2</sub>	D <sub>2</sub> -D <sub>3</sub>	
Habits													
Opened windows	6.76*	3.75*	3.13**	1.00 <sup>NS</sup>	3.13**	1.00 <sup>NS</sup>	6.14*	1.09 <sup>NS</sup>	4.00*	2.33*	3.91*	2.33**	
Closed windows	6.76*	6.76*	3.75*	6.15*	0 <sup>NS</sup>	9.00*	0 <sup>NS</sup>	9.00*	1.16 <sup>NS</sup>	6.14*	9.23*	4.00*	
Fan “ON”	2.00 <sup>NS</sup>	3.21**	1.09 <sup>NS</sup>	2.73**	6.14*	0.73 <sup>NS</sup>	6.14*	4.76*	5.18*	6.33*	5.00*	2.03**	
Fan “OFF”	2.00 <sup>NS</sup>	4.00*	6.14*	1.09 <sup>NS</sup>	3.75*	1.54 <sup>NS</sup>	3.75*	1.54 <sup>NS</sup>	3.91*	1.29 <sup>NS</sup>	3.91*	2.42**	

NS=Non-significant.  
 \* and \*\* indicate significance of values at P=0.01 and 0.05, respectively  
 D<sub>1</sub>-D<sub>2</sub> – Difference in oxygen level between day 1 and day 2.  
 D<sub>2</sub>-D<sub>3</sub> – Difference in oxygen level between day 2 and day 3.

(without any houseplant) and day two (after keeping the houseplant/s), and day two and day three (after removal of houseplant/s) which again confirms the capability of houseplants in enhancing the availability of O<sub>2</sub> in indoor air, thus improving the IES.

Conclusively, it can be expressively denoted that houseplants performed their best, whenever they are utilized, either indoor or outdoor by releasing O<sub>2</sub> and making the IAQ fresh and pure. Further, during conducting the experiments it was also observed that those areas where enough light was available the O<sub>2</sub> content was higher which may be due to better photosynthesis. Hence, one should plan enough windows specially allowing enough natural light. So plants can perform best in releasing O<sub>2</sub> in the air.

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