

STUDY ON SOME OXYGEN BOMB PLANTS FOR INDOOR AIR POLLUTION ABATEMENT

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Abstract

This experiment was conducted at Department of Botany, Dagon University and Urban Agriculture Research Division, Jeollabuk-do, Republic of Korea, from September to November, 2018. Potted-plants have the potential for improving indoor air quality (IAQ). There has been little research on the performance of green-walls as indoor bio-filters. This experiment was to compare rates of air pollution abatement with nine commonly used indoor oxygen bomb plants species, and the effects of added substrate airflows on the capacity of green-wall modules to remove indoor airborne contaminants - particulate matter (PM), and volatile organic compounds (VOCs). The oxygen bomb plants species tested were *Aglaonema crispum* (Chinese evergreen), *Anthurium andraeanum*, *Calathea makoyana* (Peacock plant), *Chlorophytum comosum* (Spider Plant), *Dieffenbachia picta* (Dumb-cane), *Epipremnum aureum* (Golden pothos), *Nephrolepis exaltata* (Boston fern), *Spathiphyllum cochlearispathum* (Peace lily) and *Zamia furfuracea* (Cardboard palm). The results showed that the ability of green-wall plants to reduce indoor air pollution, and responses to two types of pollutant such as particulate and gaseous.

Keywords: indoor air quality (IAQ), potted-plants, green-wall, bio-filtration, particulate matter (PM), volatile organic compound (VOC)

Introduction

Air pollution has become a mass phenomenon, a major and global problem of modern society, affecting billions of people and environment. People are exposed to various levels of pollutants not just in the outdoor environment, but also indoors. Indoor air pollution is ranked as one of the world's greatest public health risks (Wolverton, 1997). The United Nations Development Program estimated in 1998 that over 2 million humans die each year due to the persistence of deleterious indoor air (WHO, 2000).

Humans in industrialized countries spend about of 80% to 90% of their time indoors. But, the health burden associated with indoor air pollution does not appear to be equal for developing and developed countries (Wood, 2003).

According to the Environmental Protection Agency, chemicals from building materials, furniture, and even air fresheners can make indoor air toxic such as formaldehyde, xylene and carbon-monoxide. Reported to a NASA study, houseplants are awesome indoor air cleaners, but some of them are more effective than others at filtering out pollutants and toxic chemicals in the air. Nowadays, several studies have demonstrated the potential of biological methods to remove indoor VOCs. Common indoor plants may provide a valuable weapon in the fight against rising level of indoor air pollution.

Those plants in office or home are not only decorative, but a NASA scientist found them to be surprisingly useful in absorbing potentially harmful gases and cleaning the air inside modern buildings. Plants are the lungs of the earth; they produce the oxygen that makes life possible: they add precious moisture and filter toxins. House plants can perform these essential functions in our home or office with the same efficiency as a rainforest in our biosphere. The houseplants are the best filters of common pollutants such as ammonia, formaldehyde and benzene. An indoor plant's ability to remove these harmful compounds from the air is an example of phytoremediation. The main aim of this study about houseplants can do air cleaning

abilities. And, it aims to understand the importance of purifying indoor air with plant filter and to understand our society by growing our own fresh air to keep us healthy.

Material and Methods

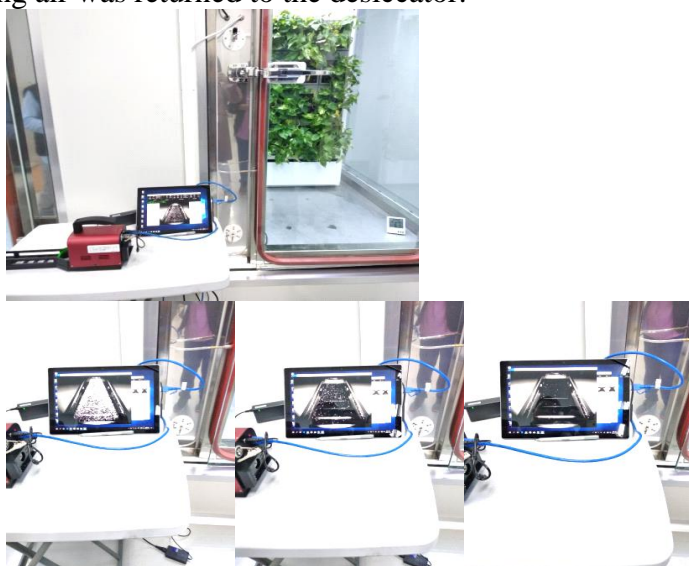
First study, nine species of plant specimens were collected and identified by using the available literatures, at Department of Botany, Dagon University, September 2018 and second study was conducted at Urban Agriculture Research Division, Jeollabuk-do, Republic of Korea, and November, 2018. Potted-plants have the potential for improving indoor air quality (IAQ) and there has been little research on the performance of green-walls as indoor bio-filters.

These plant species were chosen because of their popularity as indoor houseplants (primarily due to their low cost, low maintenance, and rich foliage) and their previously reported ability to reduce air pollutants (Wolverton, 1986, 1997).

The experiments were carried out for each plant and put in a transparent desiccator made of glass with dimension L 660× W 583× H 1286 mm. Artificial light was set at the above the desiccator.

The test plants were set in the desiccator after exposing fresh air for 24 hours and more, and then particulate matter and a small quantity of VOC gas adjusted the initial concentration was injected by a syringe three hours after the measurement start.

The measurement data of the VOC and carbon dioxide was obtained every 120 minutes for 24 hours. To avoid the air exchange between the desiccator and the outside, the exhaust air from the desiccator used for detecting the concentration of sampling air was returned to the desiccator.



Particulate matter test chamber with plants and testing removal rate

Testing particulate matter removal rate

Test starting
After 2 hours
After 4 hours

Results

Table 1. List of collected nine species of indoor plants

No.	Scientific name	English name	Family
1.	<i>Aglaonema crispum</i>	Chinese evergreen	Araceae
2.	<i>Anthurium andraeanum</i>	Painter's palette	Araceae
3.	<i>Calathea makoyana</i>	Peacock plant	Marantaceae
4.	<i>Chlorophytum comosum</i>	Spider Plant	Asparagaceae
5.	<i>Dieffenbachia picta</i>	Dumb-cane	Araceae
6.	<i>Epipremnum aureum</i>	Golden pothos	Araceae
7.	<i>Nephrolepis exaltata</i>	Boston fern	Nephrolepidaceae
8.	<i>Spathiphyllum cochlearispathum</i>	Peace lily	Araceae
9.	<i>Zamia furfuracea</i>	Cardboard palm	Araceae

Table 2. Results data of nine species indoor plants

No.	Indoor plants	Formaldehyde removal amount	Xylene removal amount	Anion generation	Relative humidity increase	Limonene content	Carbon monoxide removal amount
1.	<i>Aglaonema crispum</i>	1.56	17.7	391	17.8	8.8	6.8
2.	<i>Anthurium andraeanum</i>	2.44	12.2	91	24.4	7.6	7.9
3.	<i>Calathea makoyana</i>	0.58	1.8	806	7.0	4.4	4.2
4.	<i>Chlorophytum comosum</i>	2.5	12.5	33	22.9	5.1	6.2
5.	<i>Dieffenbachia picta</i>	2.48	4.2	530	7.3	4.6	5.0
6.	<i>Epipremnum aureum</i>	0.88	2.8	507	7.2	6.2	9.3
7.	<i>Nephrolepis exaltata</i>	1.08	3.4	248	7.6	2.2	3.8
8.	<i>Spathiphyllum cochlearispathum</i>	6.74	14.2	32	4.5	7.5	5.7
9.	<i>Zamia furfuracea</i>	2.64	12.0	30	4.2	6.6	4.3

- Scientific name – *Aglaonema modestum*
- English name - Chinese Evergreen
- Family – Araceae

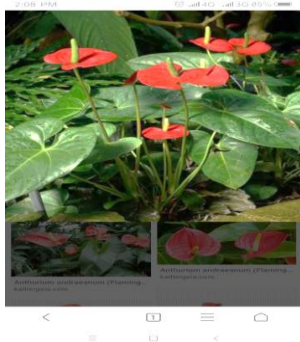
These are evergreen perennial herbs. The stem erect grown along the ground may root at the nodes. The leaf blades were variegated with silver and green coloration. The inflorescence is spadix bears unisexual flowers. This plant emits high oxygen content, and purifies indoor air by removing chemicals, such as formaldehyde, xylene, benzene or other toxins. They are thought to bring good luck and were used as decoration in Asian countries long before they made it west. Keep it near gasoline sources and carpeting.



Aglaonema modestum

- Scientific name – *Anthurium andraeanum*
- English name - Painter's palette
- Family – Araceae

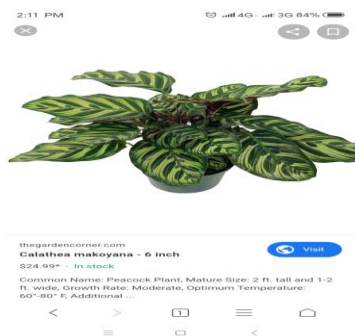
These plants are perennial and they like warm, shady and humid climate. Its most characteristic feature as an ornamental is its brightly colored spathe leaf. These are one of the plants listed in the NASA clean air study as effective in removing formaldehyde, xylene, toluene and ammonia from the air. Keep it near carpeting, bathroom or window facing traffic/road and kitchen.



Anthurium andraeanum

- Scientific name – *Calathea makoyana*
- English name - Peacock plant
- Family – Marantaceae

It is an evergreen perennial rhizomatous plant, with round, pale, glossy green leaves. The upper surface of the leaf with dark green blotches along the veins, and lower surface colored deep purple, with leaf shafts that are very thin. These plants help to purify toxins in the air. Keep it in the meeting room and cubicle areas.



Calathea makoyana

- Scientific name – *Chlorophytum comosum*
- English name - Spider plant, ribbon plant,
- Family – Asparagaceae

These are perennial flowering plants that have tuberous roots. White flowers are produced in long branched inflorescence. The inflorescences carry plantlets at the tips of their branches. The spider plant absorbs all the chemicals spray while cleaning the apartment. This plant is very simple and undemanding. These are very popular garden plants. It does not require much watering and is very adaptable for hanging basket. Keep it near carpeting, bathroom or window facing traffic/road.



Chlorophytum comosum

- Scientific name – *Dieffenbachia picta*
- English name - Dumb cane
- Family - Araceae

These are perennial herbaceous plant with straight stem, simple and alternate leaves containing white spots. These are popular houseplants because of their tolerance of shade. Its large leaf surface area helps it to quickly remove air contaminants from indoor spaces. Apart from these plants, all species of dumb cane are very easy to grow and they help in removing volatile airborne pollutants and a wide range of chemical vapor's. Keep it near the furniture.

3:33 PM 4G 84%
 < December 16, 2019 14:56



3:33 PM 4G 84%
 < December 16, 2019 14:56

Dieffenbachia picta

- Scientific name – *Epipremnum aureum*
- English name - Golden Pothos, Devil's ivy, Money Plant
- Family – Araceae

It is evergreen vine and has small green heart shaped leaves. This houseplant is commonly sold in decorative hanging baskets. This plant acts as an excellent natural anti-pollutant against common pollutants like benzene, formaldehyde and carbon monoxide. Keep it in a bedroom near the window, where it is best suited place it near the furniture.

2:24 PM 4G 82%
 bright spots, the dark green foliage is topped by spikes of pure white, cat-like flowers throughout the year. It's also one of the most efficient houseplant varieties for air purification.



Pothos
 Pothos has a reputation for being easy to grow -- and it's well-deserved. An excellent air cleaner, pothos features heart-shaped leaves variegated with white, cream, or gold. It can grow as a vine, making it perfect for hanging baskets and

Epipremnum aureum

- Scientific name - *Nephrolepis exaltata*

- English name - Boston Fern
- Family - Nephrolepidaceae

Ferns are probably one of the oldest groups, and these are evergreen perennial herbaceous plants, native to tropical regions throughout the world. The plant can grow both terrestrially and as an epiphyte, loves moist shady locations and is found frequently in swamps and floodplains. This plant likes good bright indirect light. The rachis bears monochrome sprout soups. The leaflets are entire. The Boston fern requires a certain amount of attention. It likes frequent misting and watering or the leaves will quickly turn brown and begin to drop. This fern is the best for removing air pollutants, especially formaldehyde, xylene and for adding humidity to the indoor environment. Keep it near carpeting, rubber, dry-cleaned items.



Nephrolepis exaltata

- Scientific name – *Spathiphyllum cochlearispathum*
- English name - Peace lily
- Family – Araceae

It is evergreen plant. This attractive glossy plant also produces frequent beautiful white half shaped blooms on long stems. This plant will thrive with bright indirect light. The Peace lily is a great natural remover of indoor air pollution. Pollutants like benzene, toluene, xylene, ammonia, formaldehyde and trichloroethylene are successfully filtered out. Keep it near carpeting, rubber, dry-cleaned items, tobacco smoke, gasoline, synthetic fibres, plastics, ink paints, varnishes, lacquers, oils and detergents.



Spathiphyllum cochlearispathum

Scientific name - *Zamia furfuracea*

- English name – Cardboard palm
- Family – Zamiaceae

It is a tropical perennial ornamental plant, succulent rhizome, mainly for its attractive glossy foliage and easy care. The leaves are pinnate and thickened at the bottom. The plant has air purifying qualities for the indoor environment. The plant is able to remove volatile organic compounds. Keep it suitable for open, bright room.



Zamia furfuracea

Discussion and Conclusion

This study was conducted at Department of Botany, Dagon University and Urban Agriculture Research Division, Jeollabuk-do, Republic of Korea, from September to November, 2018. Potted-plants have the potential for improving indoor air quality (IAQ). There has been little research on the performance of green-walls as indoor bio-filters.

These plant species were chosen because of their popularity as indoor houseplants primarily due to their low cost, low maintenance, and rich foliage reported ability to reduce air pollutants (Wolverton, 1986, 1997).

In present study, nine species belonging to the nine genera of five families were collected, identified and studies by using available literatures, Heywood (1993), Kapoor and Sharga (1993) and Gilbert (1994).

The second study was conducted at Urban Agriculture Research Division, Jeollabuk-do, Republic of Korea. The results data showed that the plant of *Aglaonema crispum* had highly xylene removal amount and limonene content, and *Anthurium andraeanum* had highest rate of relative humidity percent in area. The plant of *Calathea makoyana* showed maximum amount of anion generation. *Epipremnum aureum* have highly removals amount of carbon-monoxide. *Spathiphyllum cochlearispathum* showed that maximum removal amount of formaldehyde percent. The National Aeronautics Space Administration (NASA) identified indoor air pollution problems associated with sealed space habitats 16 years ago. Ornamental plants have the ability to absorb, distribute and/or transport organic pollutants to microorganisms associated with higher plants living both in the rhizosphere (Wolverton and Wolverton 1996).

Wolverton (1984) evaluated common foliage plants in controlled chambers (that simulated indoor environments) for their ability to reduce concentrations of several air pollutants. Depletion rates of known concentrations of air pollutants within the enclosed chambers containing plants were measured. He concluded that of the taxa selected, common spider plant and golden pothos most effectively reduced various air pollution concentrations (e.g., formaldehyde, nitrogen dioxide, and carbon monoxide) from closed chambers (Wolverton, 1984, 1986).

Common spider plant and most indoor ornamental foliage plants were phytoremediation of pollutants from indoor air (Soreanu *et al.* 2013). It has the ability to remove formaldehyde, nitrogen dioxide, carbon oxide, ozone, benzene, toluene, cigarette smoke and ammonia (Peart 1992; Giese *et al.* 1994; Costa *et al.* 1995; Cornejo *et al.* 1999; Wolverton 2008). In conclusion, common houseplants reduce

particulate matter (PM), and volatile organic compounds (VOCs) concentrations in a simulated indoor setting. As a method to reduce airborne contaminants, plant implementation may be cost effective and readily applied throughout the world. In particular, the plant species evaluated in this study were common, inexpensive, and easy to grow and maintain. More information is needed on species effectiveness, the number of plants required per unit area, and other environment interactions (including light, temperature, and humidity) to develop more effective recommendations.

Acknowledgements

I would like to express my deepest gratitude to express thanks to Dr Myat Myat Moe, Professor and Head, Department of Botany, Dagon University, for her kind help and invaluable guidance for this research work. I would like to give special thanks to Professor Bang Keuk Soo and Professor Park Byoung Mo, Jeonbuk National University, Republic of Korea, for their kind help and suggestion for this research work.

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