

## Role of Indoor Plants for Improving the Air Quality of Urban and Peri-Urban Areas

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### SUMMARY

Humans have a close relationship with nature, and so integrating the nature into indoor space could effectively increase people's engagement with nature and this in turn may benefit their health and comfort. Urban dwellers spend up to 90% of their lives indoors. As such, the quality of indoor air is critical to human exposure to pollution. In India, 30 to 60 deaths occurred per 1,00,000 individuals due to indoor air pollution in 2017 according to data from Institute of Health Metrics and Evaluation. Indoor pollution is composed of various constituents, which include oxidants, volatile organic compounds (VOC), and particulate matter (PM). Much though not all, of indoor pollution is directly sourced from the indoor environment itself. VOC concentrations particularly are driven by indoor emissions, traceable to petroleum-based products such as 'synthetics' in furnishings, detergents, paints, printers, air fresheners among others. VOCs may be a primary cause of 'building-related illness' and symptoms of head-ache, sore eyes or nausea. Oxidants of VOCs can also produce secondary organic aerosols, which compound the PM burden and may pose harmful health risks themselves. Indoor plants can act as indoor air purifiers, they are an effective way to reduce pollutants indoor to reduce human exposure, and have been widely studied in this regard. Indoor plants have potential applications in other fields also, including sensing, solar energy, acoustic, and people's health and comfort.

### INTRODUCTION

Plants have been studied for their ability to remove VOCs from indoor air for 25-30 years. By removing VOCs, plants are a green technology solution to problems with poor indoor air quality (World Health Organization, 2010). The efficiency by which plants remove VOCs from the air is dependent on a range of factors including plant species, light intensity and VOC concentration (Kondo et al., 1995; Liu et al., 2007; Orwell et al., 2006). In addition, it is not only the plant itself that is removing the VOCs. Microorganisms in the soil appear to play a major role as well (Wood *et al.*, 2002). Potentially, there are many factors that can affect VOC removal by plants and even though many of them have been touched upon we are still far from having discovered all there is to know about VOC removal by plants. However, the role of the indoor natural environment has received relatively little attention compared to the people spent 80–90% of their lives indoors (in both residential and public space), and longer for children, the elderly, and the sick and disable (Deng *et al.* 2018; Pandey et al. 1989; Rinne et al. 2006), there is a growing public awareness regarding the risks associated with poor indoor environment. Indoor environment is a major contributor to personal exposure to many air pollutants (Franklin, 2007). The indoor natural environment is therefore very important to human health and comfort (Claudio, 2011).

The chemical toluene, which belongs to the VOCs, can be found in indoor air environments. As a standard guideline, the Agency for toxic Substances and Disease Registry (ATSDR 2000) suggested that the toluene should not exceed 1 ppm (3.92 mg m<sup>-3</sup>) during 1-14 days of acute exposure. However, a wide range of toluene concentrations has been found. For example, in the USA, 1.1 ppm (4.14 mg m<sup>-3</sup>) was found in urban areas. Similarly, benzene is a ubiquitous trace pollutant in indoor air. Even at low dose exposure, benzene can cause leukaemia, aplastic anaemia, bone marrow disorders and some cancers in humans. A safe level of benzene exposure is unknown. In 2000, the European Union recommended that benzene concentration in ambient air should not exceed 5 µg m<sup>-3</sup>, with a long-term target of less than 1 µg m<sup>-3</sup>.

### Indoor Air Pollutants

Number of pollutants which are responsible indoor pollution are as follows:

Sr. No.	Name pollutant	Sr. No.	Name pollutant	Sr. No.	Name pollutant
1.	Benzene	4.	Naphthalene	7.	Radon
2.	Carbon monoxide	5.	Nitrogen oxide	8.	Trichloroethylene
3.	Formaldehyde	6.	Polycyclic aromatic hydrocarbons		

**Sources of Indoor Air Pollutants**

Carbon Monoxide	Formaldehyde	Nitrogen Dioxide	VOCs
-Leaking chimneys	-Building materials	-Kerosene heaters	-Aerosol sprays
-Gas heaters	-Insulation	-Welding	-Wood preservatives
-Automobile exhaust	-Paints and coatings	-Cigarette smoke	-Dry cleaned clothing
-Tobacco smoke	-Resins	-Gas stove	-Paints
	-Fertilizers		-Cleansers
			-Pesticides

These are the sources of indoor air pollutants which cause several human diseases such as asthma, allergies, reactions to mould and other particles. Plants act as filters because they absorb toxins through leaves. When plants absorb toxins, human body is protected against such diseases.

**Effects of Indoor Air Pollutants**

Sr. No.	Pollutant	Effect on human body
1.	Benzene	Acute myeloid leukaemia, Genotoxicity
2.	Carbon monoxide	Ischaemic heart disease
3.	Formaldehyde	Sensory irritation
4.	Naphthalene	Respiratory tract lesions leading to inflammation
5.	Pollutant	Effect on human body
6.	Polycyclic aromatic hydrocarbons	Lung cancer
7.	Nitrogen oxide	Respiratory symptoms, Bronchoconstriction, Airway inflammation, Reduction of immune defence leading to susceptibility to respiratory infection
8.	Radon	Lung cancer, Leukaemia
9.	Trichloroethylene	Carcinogenicity
10.	Tetrachloroethylene	Early renal disease and impaired performance

**How do We Remove These Pollutants**

In recent years Scientists of NASA, ALCA and Botanists Association in India have discussed that there are various household plants as well as plants in nature that keep air clean and pure. They also balance humidity, reduce pollutants, scrub harmful gases out of the air and help to fight pollution. NASA has recommended some plants that can be used to reduce the indoor air pollution which are as follows:

- **English Ivy:** *Hedera helix* (Araliaceae): It removes benzene, formaldehyde, trichloroethylene as well as xylene and toluene from the indoor air. It has anti-inflammatory, anti-oxidant and anti-microbial properties. It helps in relaxing airways and reducing coughs.
- **Peace Lily:** *Spathiphyllum* 'Mauna Loa' (Araceae), It removes benzene, toluene, xylene, ormaldehyde, ammonia and trichloroethylene from the air.
- **Mother in law's tongue:** *Sansevieria laurentii* (Asparagaceae), It is now called as *Dracaena trifasciata*. It removes benzene, formaldehyde, trichloroethylene as well as xylene and toluene from the indoor air. Its decoction is used for treatment in boils, cough, bronchitis and even snake bites.
- **Chinese evergreen:** *Aglaonema* 'Silver Queen' (Araceae). It removes benzene and formaldehyde from the air. Its roots are used as a tonic for children and to treat fever and dropsy.
- **Dragon tree:** *Dracaena marginata* (Asparagaceae). It removes benzene, formaldehyde, trichloroethylene as well as xylene and toluene from the indoor air.
- **Gerbera daisy:** *Gerbera jamsonii* (Asteraceae). It removes benzene, formaldehyde and trichloroethylene from the air.

- **Warnecke:** *Dracaena deremensis* “Warnecke” (Asparagaceae). It is now known as *Dracaena fragrans* “Warnecke”. It removes benzene, formaldehyde, trichloroethylene as well as xylene and toluene from the indoor air.
- **Janet Craig:** *Dracaena deremensis* “Janet Craig” (Asparagaceae). It is now known as *Dracaena fragrans* “Janet Craig”. It removes benzene, toluene, xylene, formaldehyde and trichloroethylene from the air.
- **Mass Cane:** *Dracaena massangeana* (Asparagaceae). It is now known as *Dracaena fragrans* “Massangeana”. It removes benzene, formaldehyde, trichloroethylene as well as xylene and toluene from the indoor air.
- **Bamboo Palm:** *Chamaedorea seifritzii* (Arecaceae). It removes benzene, toluene, xylene, formaldehyde and trichloroethylene from the air.
- **Golden Pothos:** *Scindapsus aureus* (Araceae). It is now known as *Epipremnum aureum*. It removes benzene, formaldehyde, xylene and toluene from the indoor air.
- **Pot mum:** *Chrysanthemum morifolium* (Asteraceae). It removes benzene, toluene, xylene, formaldehyde, ammonia and trichloroethylene from the air. It is used to treat high blood pressure, diabetes and headache.
- **Heart Leaf Philodendron:** *Philodendron oxycardium* (Araceae). It is now known as *Philodendron cordatum*. It removes formaldehyde from the indoor air.
- **Elephant Ear Philodendron:** *Philodendron domesticum* (Araceae). It removes formaldehyde from the air.
- **Spider plant:** *Chlorophytum elatum* (Asparagaceae). It is now known as *Chlorophytum cosmosum*. It removes formaldehyde, xylene and toluene from the indoor air.
- **Lacy Tree Philodendron:** *Philodendron selloum* (Araceae). It is now known as *Philodendron bipinnatifidum*. It removes formaldehyde from the air.

## CONCLUSION

The potted plants represent an innovative technology for solving indoor air pollution, which otherwise cause a series of harmful effects. This portable, flexible, attractive, low cost technology can be used in any building. To ensure sustainability of the urban environment, indoor plants can be expected to become standard technology for improving the indoor air quality.

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