



*Review Paper*

**SOME INDOOR PLANTS AND THEIR ROLE IN REDUCING INDOOR POLLUTION**

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**Abstract**

*Due to increase in industrialization and urbanization, pollution also increase which affects the human health directly or indirectly. There are many types of pollutions but indoor air pollution is very serious and dangerous to human health. Urban people generally spend 80-90% of time indoors. Indoor air can often contain 5 To 7 times the contaminant concentrations of out- door air. Indoor plants improve indoor air by reducing air-born contaminants such as VOCs, nitrogen oxides, and dusts. The studies show that indoor plants can reduce indoor air pollutants by 75% in different conditions. Indoor plants can provide an efficient, self-regulating low-cost, sustainable, bioremediation system for indoor air pollution, which can effectively compliment engineering measure to reduce indoor air pollution and improve human well-being and productivity. This review is mainly focusing on indoor air pollution its categories, sources and remediation by the use of some listed indoor plants.*

Key words: Industrialization, urbanization, pollution, pollutants, sustainable, bioremediation, indoor and out-door plants.

**INTRODUCTION**

Air pollution in India is a serious problem which affects the human health. There are many types of air pollution but indoor air pollution is very serious and dangerous to human health. Indoor air quality is of great importance since it has an effect on human health especially in developing countries where people spend their time indoors. Indoor air pollution refers to chemical, biological and physical contamination of indoor air. It may results in adverse health effects. Indoor air can often contain 5 to 7 times more contaminant concentrations of out-door air[1-2]. The harmful effects of contaminant concentrations have been recognized as components of "sick building syndrome" or 'building-related'[3-4], with symptoms of headache, dizziness, nausea, sore eyes and throat or loss of concentration. In the United States alone, about 27 million office

workers are at risk of sick building syndrome, and 30% of new buildings worldwide are associated with indoor air pollution problems[5]. Exposure to nature is considered beneficial to physical and mental health[6]. This is why people often grow plants indoors to improve the air quality of their living environment and workplaces[7], because plants represents nature[8-9]. Empirical studies have also demonstrated that indoor plants have positive effects on physical and mental health as well as general wellbeing[10-11]. A number of studies have shown that potted plants (indoor) have a capacity contribute to the improvement of indoor air quality, by reducing air-borne contaminants such as VOCs, Nitrogen oxides and dusts[12-15], as well as by aiding humidity, temperature and noise [16]. In developing countries including India, the main source of indoor pollution is biomass smoke which contains suspended particulate matter (SPM), nitrogen dioxide (NO<sub>2</sub>), sulphur dioxide (SO<sub>2</sub>), carbon monoxide (CO), formaldehyde and polycyclic aromatic hydrocarbons (PAHs).

In industrialized countries, in addition to NO<sub>2</sub>, SO<sub>2</sub>, CO, formaldehyde, radon, asbestos, mercury, human made mineral fibers, volatile organic compounds, allergens, tobacco smoke, bacteria, viruses and molds are main contributors of indoor air pollution.

### Types of indoor air pollution:

Air pollution is a globalized problem because the people are unaware of pollution caused by burning of wood, animal dung and charcoal for cooking and heating purpose in their homes. Every year about 3 million people die prematurely due to indoor air pollution [20].

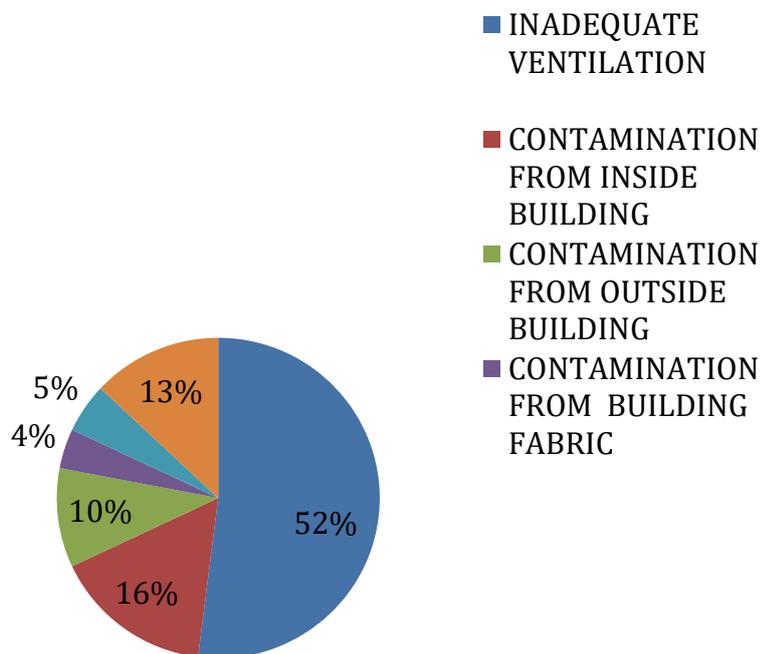
There are number of indoor air pollutants and have different sources from where they originate in houses and office buildings. Some pollutants can be drawn from outdoor sources, hence all these pollutants get trapped and accumulates indoor.

**Table 1: shows various types of pollutants, their sources and effects on human health.**

S. N.	Name of indoor air pollutants	Sources	Effects on human health	References
1.	Aldehydes	Construction materials, Cooking and Furnishing.	Breathing problems, cancer, Headache, Decreasing immunity.	[21]
2.	Arsenic and Fluorine	Combustion of coal	Numbness, skin lesion, Diarrhea, Muscle cramping and death.	[22]
3.	Asbestos	Demolition of construction materials.	Lung cancer, cancer of Kidney, Brain, Urinary bladder, gall bladder, Throat voice box etc.	[23]
4.	Biological pollutants	Furnishings, Moist area, Ventilation system Bacteria, Viruses, Mites, Cockroaches Pollens.	Sneezing, Coughing, Watery eyes, Shortness of breath, Dizziness, Lethargy, Lung diseases	-

5.	Carbon monoxide	Fuel, Tobacco combustion, Wood stove.	Interferes with oxygen supply, Headache, Fatigue, Retarded reflexes due to CO exposure.	[24]
6.	Hydrocarbons	Fuel combustion, Heating, Cooking.	Failure of nervous system, Causes cancer	[21]
7.	Lead	Wear of painted surfaces	Attack on brain and CNS to cause Coma	[25]
8.	Nitrogen oxides	Fuel combustion, Tobacco smoke.	Pulmonary disease, impairment of lung function, and irritation in eye, nose and throat.	[26]
9.	Ozone	Printers, Photocopiers, Air purifying devices.	Throat irritation, Cough, Pain, burning or discomfort in the chest, Chest tightness, Wheezing and shortness of breath.	[22]
10.	Particulate Matters	Tobacco smoking, Fuel combustion, Fumes from cooking oils.	Eye, nose and Throat irritation, Asthma, Various lung and cardiovascular disorders.	[25]
11.	Pesticides	Dust from outside, consumer products	Blood and nerve disorders, Genetic disorders, Endocrine disruption, and Reproductive problems.	[27]
12.	Radon	Burning of Coal and other fossil fuel, Construction materials, Soil gas and Tap water.	Leukemia, Increase the risk of lung cancer caused by smoking, Cancer in minors.	[28]
13.	Sulphur oxides	Fossil fuel combustion	Impairs lung function adversely, Causes Cardiovascular diseases, Irritate skin and mucous membrane of the eyes, nose, throat and lungs.	[26]
14.	Trichloroethelene (TCE)	Varnishes, lubricants, Adhesives, Typewriter correction fluid, Paint removers.	Effects on Liver, Kidney, CNS, Reproductive and Immune system.	[29]
15.	Volatile & Semi-volatile organic compounds	Construction materials, Fumes from cooking, Fuel/Tobacco combustion and Consume products.	Carcinogenic and Toxic effects.	[21]

## SOURCES OF INDOOR AIR POLLUTANTS



### Traditional air purification methods:

There are several methods used traditionally for improving indoor air quality.

**Activated charcoal:** Activated charcoal is a natural purifier. A fantastic way to purify indoor air is with activated charcoal, also referred to as active carbon. It is odorless, highly-absorptive and works wonders with eliminating toxins from the air. Another fantastic way to purify air at home naturally is bamboo charcoal.

**Ban on smoking:** Smoking is a very dangerous for the person who is smoking as well as for the passive people living in house also. Smoking leads to emission of volatile organic compounds, particulate matter and carbon monoxide. So avoid smoking in house it can prevent many carcinogenic gaseous emissions.[19].

**Beeswax Candles:** Beeswax candles act as natural air purifiers. They are especially helpful for asthmatics and neutralize the toxins and common allergens like dust from indoor air. Beeswax candles produce the ions which combined with free floating chemical ions making them heavier and fall off to ground [17].

**Essential oils:** In the presence of essential oils like cinnamon, Oregano, Rosemary, thyme, grapefruit lemon, Clove, tea tree etc. Viruses, Fungi, Bacteria and even mold cannot survive. Studies from Weber State University show that Thieves oil has a 99.96% kill rate against airborne Bacteria.

**HEPA Filter:** These filter helps in grasping all the accumulated dust particles like lead particles, brominates fire retardant chemicals (PBDEs). They are commonly known as air purifiers, which are very beneficial for the allergic people as it can capture large amount of biological and chemical allergens [18].

**Mopping:**Mopping is a very old method to clean all dust particles settled down on the floor surface that is left behind the vacuum cleaner. Due to water all the dust particles get stick to mops fiber and provide the clean surface [18].

**Salt Lamps:**A salt lamp is another great natural air purifier. Salt crystal products tend to reduce airborne irritants, pathogens and allergens by pulling water vapours out of the air.Himalayan pink salt is a natural ionic air purifier that absorbs toxins from the environment and neutralizes them. Salt lamps improve air purification much more when they are turned on, but surprisingly work when turned off too[17].

**Ventilations:**Ventilating homes reduces moisture levels, a major problem for indoor air quality. Scientists who measured indoor air quality found that cooking a single meal on a gas stove can produce levels nitrogen dioxide that the EPA considered unsafe to breathe. Ventilation help in maintaining the air flow, exhaust fans in kitchen, proper windows and sunlight exposer in home removes foul odor, germs and indoor pollutants [19].

Above mentioned methods are in use since long time and they are very effective. Due to urbanization, industrialization and increasing anthropological activities, the level of pollution is much more now. So, more effective methods needed to improve indoor air quality. These methods are less expensive, easy to apply, natural and required low maintenance.

Above stated traditions methods are having some limitations so newer natural technique has come in account. Bioremediation is a natural technique which is waste management systems that removes or neutralize pollutants from contaminated sites by using organisms.For the removal and detoxification of organic pollutants, phyto-volatilization, phyto-stabilization, rhizofiltration and rhizodegradation can be use. Similarly for inorganic pollutants, phytoaccumulation, phytovolatilization, phytostablization and rhizofiltration technique are used. These techniques are natural, low cost and solar energy driven process that is quite effective and ecofriendly.

**Table 2: Various Indoor plants and Pollutants removed by them.**

S. N.	Indoor plant	Benze ne	O <sub>3</sub>	Toulene & Xylene	Formaldeh yde	TCE	Ammon ia	Hydrocarbo ns	Referenc es
1.	Aglaonema modestum (Chinese Evergreen)	+	-	-	+	-	-	-	[13]

2.	Aloe vera (Aloe vera)	+	-	-	+	-	-	-	[13]
3.	Anthurium andreaeanum (Flamingo lily)	-	-	+	+	-	+	+	[13]
4.	Chamaedoreas eifrizii (Bamboo Palm)	-	-	+	+	-	-	-	[13]
5.	Chlorophytum comosum (Spider plant)	-	+	+	+	-	-	+	[13,30,31]
5.	Chrysanthemum morifolium (Florist's chrysanthemum)	+	-	+	+	+	+	-	[13]
6.	Dieffenbachia spp. (Dumb canes)	-	-	+	-	-	-	+	[13]
7.	Dracaena marginata (Red-edge-draceana)	+	-	+	+	+	-	-	[13,32]
8.	Dyopsis lutescens (Areca palm)	-	-	+	+	-	-	-	[32,33]
9.	Epipremnum aureum (Devil' ivy) Money plant	+	-	+	+	-	-	-	[31]
10	Ficus benjamin (Weeping fig)	-	-	+	+	-	-	+	[13]
11	Ficus elastica (Rubber plant)	-	-	-	+	-	-	-	[30]
12	Gerbera jamesonii (Barberton daisy)	+	-	-	+	+	-	-	[32]
13	Hedera helix (English lily)	+	-	+	+	-	+	+	[13,34]
14	Homamena wallisii (King of hearts)	-	-	+	-	-	-	-	[13]
15	Liriope spicata (Lily turf)	-	-	+	+	-	-	-	[13]
16	Musa oriana (Banana)	-	-	-	+	-	-	-	[32]
17	Nephrolepis exaltata (Boston fern)	-	-	+	+	-	-	-	[13]
18	Nephrolpis obliterate (Kimberley queen fern)	-	-	+	+	-	-	-	[13]
19	Phalaenopsis spp. (Moth orchids)	-	-	+	-	-	-	-	[13]

20	Philodendron <i>cordatum</i> (Heartleaf philodendron)	-	-	-	+	-	-	+	[32,35]
21	Philodendron <i>domesticum</i> (Elephant ear philodendron)	-	-	-	+	-	-	+	[32,35]
22	Phoenix <i>roebelenii</i> (Dwarf date palm)	-	-	+	+	-	-	-	[13,32]
23	Rapisexcels (Lady palm)	-	-	+	+	-	+	-	[13]
24	Sansevieria <i>trifasciata</i> "Laurentii" (Variegated snake plant) Mother-in law's tongue.	+	+	+	+	+	-	-	[13,31]
25	Spathiphyllum <i>wallisii</i> (Peace lily)	+	-	+	+	+	+	+	[13,34,36 ]

According to NASA experiment, published in 1989, indoor plants can scrub the air of cancer causing volatile organic compounds. There are different plant varieties which absorbs various pollutants from the indoor. This study revealed that **Benzene** efficiently removed from home by *Aglaonema modestum*, *Aloe vera*, *Chrysanthemum morifolium*, *Draceana marginata*, *Epipremnum aureum*, *Gerbera jemesonii*, *Hedera helix*, *Sansevieriat rifasciata* and *Spathiphyllum wallisii* plants. *Sansevieria trifsciata* and *Chlorophytum comosum* are helpful in removal of Ozone [33, 34]. Except Plant species like *Aglaonema modestum*, *Aloe vera*, *Ficus elastica*, *Gerbera jemisonii*, *Musa oriana*, *Philodendron cordatum* and *Philodendron domesticum* all removes Toluene and Xylene. Out of 25 indoor plants with serial No. 22, 05, and 07 plants absorb formaldehyde, TCE, Ammonia, and hydrocarbons respectively. *Nephrolepis obliterate* is very effective in removing air borne germs, molds and Bacteria from the indoor air. According to NASA studies Bacterial counts is directly depends on plants ability of removing pollutants. Bacteria like *Alcaligenes*, *Bacillus*, *Micrococcus* and *Myxococcus* are found in soil in which Snake plant grows. Similarly *Aureobacterium*, *Bacillus*, *Curtobacterium*, *Micrococcus*, *Pseudomonas* and *Sterptomyces* were found in soil of Peace lily [37].

#### CONCLUSION:

Indoor air pollution appears to be a major environmental and public health hazard for large number of developing countries. Many studies on indoor plants as remover of indoor pollutants are done by many workers, shows conclusively that the indoor plants can greatly improves IAQ by removing many major indoor air pollutants. The studies done throughout the world clearly indicates that indoor plants can provides an efficient,

self-regulating, low cost, sustainable, bioremediation system for indoor air pollution, which can effectively complement engineering measures to reduce indoor air pollution, and hence improve human wellbeing, prosperity and productivity.

Indoor plants can effectively remove indoor contaminants such as Volatile organic compounds, CO, CO<sub>2</sub>, O<sub>3</sub>, Ammonia, Benzene, Formaldehyde, Trichloroethylene, Airborne molds and Bacteria. This paper reviews the capacity of indoor plants to contribute to filter indoor air, and lay the foundation for the development of indoor plant system as a complementary bio filtration system. It is expected that indoor plants will become standard technology for improving IAQ.

#### **Future aspects:**

Increasing population urbanization, industrialization and changing lifestyle indicate that pollution will not stop increasing in the future. Since we all are aware about the effects of air pollution on both health and environment. It is necessary to wake up and do something to protect the present and future generations. The countries with high population such as China, India and America should start new research in this direction. Much research has been done on outdoor pollution, indoor air pollution now needs attention and need to be worked upon. If an indoor plant is not able to remove indoor air pollution, then its capacity should be increased by genetic modification so we can keep the indoor environment clean in future. Today, there is a need to create effective guideline for indoor pollution prevention in developing countries so that hospitals, schools, offices and residential buildings can be kept free from indoor pollution.

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