



## ROLE OF FERNS IN REDUCING INDOOR AIR POLLUTION: A REVIEW

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### ABSTRACT

In modern times pollution has become the biggest menace for the survival of the biological species with rapid industrialization and random urbanization environmental pollution has become a serious problem. Over exploitation of open spaces, ever increasing number of automobiles and demographic pressure has further aggravated the problem. Planting of trees and shrubs for abatement of pollution and improvement of environment is an effective way and well recognized throughout the world. Pollution is defined as ‘an undesirable change in physical, chemical and biological characteristics of air. Plants play an essential role to clean the pollution in human environment. Did You knows that ferns remove toxic chemicals from indoor spaces? Ferns came out on top for eliminating formaldehyde (an irritant and cancer-causing pollutant) found at low but significant levels in a wide variety of indoor products such as carpet, flooring, paper products, particleboard, and plywood – lots of places! Ferns are also very efficient at removing xylene and toluene that are also common in indoor air spaces. Some other common cleaners are Spider plant, Palms, such as Areca Bamboo and dwarf Date palms; as well as other ferns, English ivy, Peace lilies, Chinese evergreens and Weeping Ficus. Common indoor plants can prove to be a valuable weapon when it comes to fighting the rising levels of indoor pollution.

**KEYWORDS:** Air Pollution, Pollutants, Plants, Indoor Pollution, Fern

In fact, the Commonwealth Scientific and Industrial Research Organization estimates that occupants of new homes may be exposed to many times the maximum allowable limits of indoor air pollutants such as formaldehyde and benzene. Exposure to formaldehyde irritates the eyes, nose and throat, can cause headaches and allergic contact dermatitis, and has been linked to asthma. Benzene irritates the eyes and skin. Indoor air pollution is caused mainly by synthetic building materials, finishes and furnishings that off-gas pollutant. It is also caused by the use of personal-care products, pesticides and household cleaners and by biological sources such as insects, pests, molds and other fungi. There are numerous indoor sources of air pollutants relate to combustion processes and others relate to human activities.

Although homes and offices may seem pristine, indoor air may contain volatile organic compounds, which usually have some sort of odor; benzene, usually from fabrics, plastics or cigarette smoke; or formaldehyde, found in detergents and cleaners as well as some cosmetics. In areas near high voltage or smog, ozone can be an additional pollutant. These pollutants have been linked with a number of adverse health conditions.

According to the EPA (Environmental Protection Agency), the levels of indoor air pollution in

our home may be between two and five times higher than they are outside. Some of the different pollutants we breathe can even be as much as 100 times more concentrated inside. Both the National Cancer Institute (NCI) and the Centers for Disease Control and Prevention (CDC) have established that 80 percent of all cancers may be attributed to factors from our environment. Both builders and homeowners can improve indoor air quality (IAQ). Builders can help by using green building materials instead of materials that contain volatile organic compounds, as many traditionally manufactured carpeting, cabinets, drywalls and paints do. Builders also can design adequate ventilation systems that effectively remove toxins and replace them with fresher air. Homeowners can contribute to improving IAQ by reducing the amount of synthetics and known pollutants they use at home and by opening windows and doors for fresh air as seasonally appropriate. Another important way homeowners can improve IAQ (indoor air quality) is to add live indoor plants. Certain indoor plants have been proven to help absorb harmful toxins in the air, such as formaldehyde, benzene, trichloroethylene and carbon monoxide. Boston ferns may help reduce these pollutants. (John *et al.*, 2009)

The plants eat the chemicals and process them to create energy. The chemicals are broken down into useful entities such as organic acids, sugars and amino acids. Plants pull down oxygen and any other chemicals in the

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air into their root systems, where all chemicals are processed and released as harmless--and beneficial--water vapor. Plants take in water, air and chemicals through their roots and leaves and process those components primarily in the root system. The root system is where important nutrients are broken down and made available to the plant. The plant gets the energy to perform this function and many others through a process called photosynthesis, using light to change water and the carbon dioxide in the air into energy. Just as we need oxygen to survive, and a richly oxygenated environment to thrive, plants need carbon dioxide. Fortunately, there is a perfect balance between flora and fauna; we need oxygen, but release carbon dioxide while plants need carbon dioxide, and give off oxygen.

**PHYSIOLOGY OF FERN**

There are numerous indoor atmospheric pollutants. Specifically, combustion sources, building materials, volatile organic compounds, central heating and cooling system are described. (Table 1)

Plants have been used for remediation of pollutants from air, soils, and water, which has been termed as phytoremediation (Cunningham *et al.*, 1997; Salt *et al.*, 1995; Huang *et al.*, 1997. The word phytoremediation comes from the Greek word phyto meaning -plant and the Latin word remediare, meaning to remedy. This word is generally used to describe any system where plants are introduced into an environment to remove contaminants from it (Chhotu and Fulekar, 2009). Certain species of higher plants can accumulate

very high concentrations of metals in their tissues without-showing toxicity (Klassen *et al.*, 2000). There are four main ways by which plants reduce air pollution (Kapoor 2017)

These are:

- 1- Temperature Reduction
- 2- Removal of air pollutants
- 3- Emission of VOCs (Volatile organic compound)
- 4- Energy effect on building

Air Pollution Tolerance Index (APTI) which gives an empirical value for tolerance level of plants to air pollution was determined using the formula (Kapoor 2017). The formula for ATPI is-

$$ATPI = \frac{A(T + P) + R}{10}$$

Where A = ascorbic acid (mg/ g), T = total chlorophyll (mg/g), P = pH of leaf extract, R = relative water content of leaf extract.

Ascorbic acid has been reported to play an important role in cell wall synthesis, photosynthetic carbon fixation, and cell division vis-à-vis resistance of adverse environmental conditions including air pollution . Air pollutants get their entry in to plant system through stomata and cause partial denaturation of chloroplast and decrease pigment content due to replacement of Mg ions with hydrogen atoms (Kapoor 2017). Chlorophyll degradation leads to lower carbon dioxide fixation. Higher chlorophyll content might favour the plants to tolerate pollution better (Agrawal 2017).

**Table 1: Sources of the main Indoor air pollutants (adapted from CRAB 2005)**

S.No.	Pollutants	Main Sources
1	Arsenic	Coal Combustion
2	Asbestos	Building material in older homes released during renovation, naturally occurring in some soil
3	Biological agents (Bacteria, fungi, Viruses, house dust, Mites, and mites, cockroaches, microbial IVOCs)	House and Floor dust, pets, bedding, poorly maintained air conditioners, humidifiers, moist structures or furnishing, insect infestation, building occupants
4	Carbon monoxide	Uneven tad or malfunctioning gas appliances, wood stoves fireplaces, tobacco smoke.
5	Endocrinesruptors (Phthalates, DDT, chlordane, heptachloro, phenylphenol, PBDEs)	Plastic, Pesticides, flame retardants
6	Environmental tobacco Smoke	Cigarettes, cigars, and pipes
7	Formaldehyde, other aldehydes	Composite wood product, such as plywood and particle board, furnishing wallpapers, paints, combustion, appliances, tobacco smoke.
8	Lead	Lead paints chips, contaminated
9	Nitrogen dioxide	Unvented or malfunctioning gas appliances,

10	Other combustion appliances Organic chemicals (benzene, chloroform, paradichloro benzene, methylenechloride, perchloroethylene, phthalates, styrene)	Solvents; glues; cleaning agents; pesticides; building materials; paints; treated water moth repellents; dry-cleaned clothing; air fresheners
11	Ozone	Infiltration of outdoor air, ozone generating airpurifiers,
12	office machines Particulate matter	Cigarettes, wood stoves, fireplaces, cooking, candles, aerosol sprays, house dust
13	Polycyclic aromatic hydrocarbons	Cigarette smoke, cooking, wood burning
14	Radon	Uranium-bearing soil under buildings, groundwater

## DISCUSSION

It is well known that plants take in carbon dioxide and give off oxygen, but in the late 1980s, NASA revealed that many common houseplants scrub other chemicals from indoor air. Some of the most common indoor air pollutants are formaldehyde, benzene and trichloroethylene. These chemicals are released over time from man-made products in our homes. Treated wood, paint, carpet, furniture and cleaning products release these chemicals, which are also called volatile organic chemicals (VOCs). The Boston fern is one of the best plants for removing them from the air.

### Boston Fern (*Nephrolepis exaltata* “Bostonians”)

This plant is a little more high maintenance than other plants. The leaves must be misted and watered to keep them from turning brown and wilting The Boston Fern is the best plant tested for removing air pollutants, especially formaldehyde, and adding humidity to the air.

### Chinese medicinal fern (*Blechnum orientale*)

*B. orientale* was found to grow vigorously even with extremely high levels of arsenic (As, 142 mg·kg<sup>-1</sup>) in the fronds at sites severely polluted by heavy metals. Usually, the concentration of As was below 1.0 mg·kg<sup>-1</sup> in most terrestrial plants .Uptake of pollutants via stomata might be the main reason causing the significant accumulation of hazardous pollutants in the fronds of *B. orientale*. (Xiao-minZhu *et al.*, 2013)

### Kimberley Queen (*Nephrolepis obliterated*)

Not as well-known as the Boston fern, and also not as sensitive to low humidity, the Kimberley Queen is better suited to an indoor environment. This fern is also as effective at removing toxins as the Boston fern. Highly effective for the removal of formaldehyde and alcohols. High transpiration rate makes it a natural humidifier. It requires a regular schedule of watering and misting. Keep the soil moist, but not wet. Feed with diluted liquid fertilizer as long as the plant produces new fronds. Never

allow the root ball to dry completely. It prefers to be somewhat potbound in a standard container filled with humus-rich potting soil or a soil-less mix. Less frequent watering is required if grown using hydro culture or sub-irrigation.

10 Indoor Plants that Improve Air Quality common indoor plant can prove to be a valuable weapon when it comes to fighting the rising levels of indoor pollution. The NASA Clean Air Study, led by the National Aeronautics and Space Administration in association with the Associated Landscape Contractors of America (ALCA), established in 1989 that indoor plants can be extremely useful in absorbing harmful gases and clean the air indoors.

The indoor pollutants that affect the health are:-

- Formaldehyde, which comes from carpets and particle boards.
- Volatile Organic Compounds (VOCs) which comes solvents and chemicals in perfumes, hair sprays, air fresheners and furniture polish.
- Biological pollutants which constitute of dust, fungi, allergens.
- Carbon monoxide and nitrogen dioxides.

All these pollutants contribute to sick building syndrome, which cause symptoms ranging from allergies, headaches, and dizziness to nervous system disorders, cancer and death.

## 10 Air Indore Plants

### Aloe Vera (*Aloe barbadensis*)

Aloe Vera is a succulent, perennial plant that has the ability to filter benzene and formaldehyde. There are about 250 varieties we can choose from. It is easy-to-grow and requires a lot of sunlight.

### Spider Plant (*Chlorohytum comosum*)

NASA has named the Spider Plant is one of the best indoor plants to remove formaldehyde from indoor air. It also battles benzene, carbon monoxide and

xylene. WE can neglect this plant all want, but its resilience keeps it alive.

#### **Gerber Daisies (*Gerbera jamesonii*)**

Gerber Daisies have bright and colourful flowers. Not only do they look beautiful, they are great at absorbing carbon monoxide and benzene. This plant gives off oxygen at night; it is ideal for bedrooms.

#### **Snake Plants (*Sansevieria trifasciata 'Laurentii'*)**

Also known as mother-in-law's tongue, this plant is one of the best at filtering out formaldehyde. It also helps in eliminating nitrogen dioxide. Even at night, it takes in carbon dioxide and releases oxygen. This makes for a good bedroom plant. It requires minimal sunlight and water and is not very difficult to maintain.

#### **Golden Pothos (*Scindapsus aureus*)**

This fast-growing vine is great at battling formaldehyde. It grows in any type of light with an exception to sunlight and is very easy to maintain. However, it is toxic if consumed. So, if you have kids running around indoors, this one is not for you.

#### **Chrysanthemum (*Chrysanthemum morifolium*)**

The colorful, bright flowers do a lot more than brighten up the place. It is a seasonal flower, and for the six weeks that it does bloom, it is great at combating benzene. It needs a lot of sunlight to bloom; you want to place it at a place where it receives direct sunlight.

#### **Red-edged dracaena (*Dracaena marginata*)**

The red-edged leaves of this plant remove xylene, trichloroethylene and formaldehyde. It is slow-growing and add colour to the environment. However, it is poisonous if consumed by pets.

#### **Bamboo palm (*Chamaedorea Sefritzii*)**

This plant is a natural humidifier which can be beneficial in areas with dry air. It helps eliminate carbon monoxide, xylene, benzene and formaldehyde. They thrive in shady indoor spaces and often produce small flowers and berries.

#### **Weeping fig (*Ficus benjamina*)**

This plant is useful in fighting benzene, formaldehyde and trichloroethylene. It is a little difficult to maintain this one. It needs a lot of attention vis-à-vis water and sunlight.

#### **Warneck dracaena (*Dracaena deremensis 'Warneckii'*)**

This plant can reach a height of about 10 feet. It makes for a rather striking houseplant. It helps eliminate

VOCs, benzene, formaldehyde and trichloroethylene. It doesn't need too much light to grow

## **CONCLUSION**

Considering the present scenario of urban environmental pollution, there is a growing need for changing the approach of planting trees and other plant species. Inclusion of the ornamental plants having pollution mitigating ability in the landscape plan will serve the dual purpose of making the cities green and pollution free in the long run. Proper planting scheme will bring healthy life and colour in the cement concrete jungle of large congested cities. Plants enhance our environment, just as we enhance theirs. The benefit to filling our house with beautiful--and inexpensive--Boston ferns is clear. There is no easier way to clean the air that we, our family and pets breathe than by using common houseplants as air filtration systems. But do not discount the importance of actual air circulation: Always open doors and windows whenever you can to let out the old, stale air and let in the new. Other benefits include higher oxygen levels indoors, higher humidity, which is especially nice if people live in an arid climate, and even lower stress levels. Wallace *et al.* (2009) has shown how emissions from these sources have changed over the past 50 years with a decrease in levels of "known" carcinogens and an increase in exposures to suspected endocrine disruptors. The variability of pollutants indoors is high and may be house specific. Sociological factors are at play when considering exposure to indoor air pollution. Often the concentrations of air pollutants can be higher inside the dwelling of the poor. In developing countries women and their young children are likely to spend more time in the kitchen and so are at greatest risk from exposure of high levels of pollution from biofuels. The indoor environment can be subdivided into different micro-environments (e.g. school, transport, restaurant and residential) areas and each may have a different source of indoor pollution. "If man is to move into closed environments, on Earth or in space, he must take along nature's life support system." Plants. One of the NASA experiments testing this solution was the BioHome, an early experiment in what the Agency called "closed ecological life support systems." The BioHome, a tightly sealed building constructed entirely of synthetic materials, was designed as suitable for one person to live in, with a great deal of the interior occupied by houseplants. Before the houseplants were added, though, anyone entering the newly constructed facility would experience burning eyes and respiratory difficulties, two of the most common symptoms of Sick Building Syndrome. Once the plants were introduced to the environment, analysis of the air quality indicated that

most of the VOCs had been removed, and the symptoms disappeared. (NASA report later published by Wolverton *et al.*, in 1989)

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