

Air Purifying Plants: A Boon of Nature

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How to cite this paper: Dr. Amita Sharma "Air Purifying Plants: A Boon of Nature" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-4, June 2019, pp.1807-1811, URL: www.ijtsrd.com/papers/ijtsrd25321.pdf



IJTSRD25321

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INTRODUCTION

Our environment has been deteriorated markedly in the last few years due to rapid increase in environmental pollution. Depletion of forests, population growth, vehicular emissions and various other undesirable human activities are mainly responsible for this degraded scenario of environmental health in India. Now it is essentially advisable to become protector, producer and care taker of motherland and not the predator, polluter and consumer of earth. There is no need to dish out hundreds of dollars on expensive appliances when we have got Mother Nature. According to NASA there are plenty of plants that soak up harmful particles in the air and release fresh oxygen – all while adding a decorative touch. House plants are awesome indoor air cleaners, but some of them are more effective than others at filtering out pollutants and toxic chemicals in the air. Spider plant (*Chlorophytum comosum*), Boston fern (*Nephrolepis exaltata*), Areca palm (*Dypsis lutescens*) and Peace lily (*Spathiphyllum*), eliminate formaldehyde and xylene from the air around it. Golden Pothos (*Epipremnum aureum*) also known as Devil's Ivy is also considered one of the most effective indoor air purifiers for removing common toxins. Bamboo palms (*Chamaedorea seifrizii*) also transpire a healthy dose of moisture into the air and is resistant to insect infestation. Snake plant (*Sansevieria trifasciata*) prevents formaldehyde that leaks from carpet and wood furniture from sticking around the air. It emits oxygen during the night time making the rooms air fresh and clean. *Aloe vera* is also one of nature's miracle plants which also plays a very important role in cleaning air around it.

The apparent pollution seems to be external from the windows of our houses, but recent studies and researches have shown that the four walls in which we live are no less

ABSTRACT

This reviewed paper deals with air purifying plants which improve the air quality and increase the oxygen level. The important air purifying plants discussed in this reviewed paper are Holy basil, Money Plant, Bamboo Plant, Snake Plant, Orchids, Spider plants, Peepal and Aloe vera. This paper explains the Phytoremediation, a process used to clean the environment through plants. Plants like *Ficus*, *Spathiphyllum*, *Chrysalidocarpus*, *Dracena*, *Raphis*, *Deiffenbachia*, *Philodendron*, *Epipermum*, *syngonium*, *Sanseveria*, *Codiaeum* and *Cyprus* have been tested to reduce the airborne pathogens and pollutants. Paper explains the importance of trees in reducing pollution and also volatile organic compounds (VOCs). Conifers are very important in minimising the air pollution. So by growing these plants in house, offices and gardens etc. the pollution index can be reduced. Cities usually come at the price of green space. Since prehistoric times, humans have heavily cut forests to make way for settlements. Now, due to awakening call, greenery has been edging its way back into modern urban landscapes. Thus vegetation will help cities to become better habitats for wildlife and for people, and it will help to make city air safer. Tree plantation and forest conservation is the only way to get pure air to inhale i.e PRANVAYUU.

Keywords: Air Purifying Plants, phytoremediation, Conifers, VOCs, airborne pathogens

than sources of air pollutants emitted from different and basic activities which includes cooking, cleaning, painting, washing and many more which are unavoidable. Several air purifiers and filters are available in the market, but they seem to be miles away from the hands of an ordinary man, hence for a sustainable management of this dilemma there are few indoor plants having an inherent capacity of purifying the indoor air quality by the plant mechanism termed as phytoremediation.

While trees are generally effective at reducing air pollution, it isn't as simple as the more trees you have in an urban space, the better the air will be. Some trees are markedly more effective at filtering pollutants from the air than others. To improve the air quality in a street or city, the right tree should be planted at that place.

SOME IMPORTANT AIR PURIFYING PLANTS:

There are many plants which purify air but some commonly grown plants are discussed here.

PEEPAL TREE

Ficus religiosa or Peepal tree is the tree which purifies air the most. Plants purifying air can generally be described as in taking of CO₂ for photosynthetic pathways and release of O₂ as a result. There are three types of photosynthetic pathways for using CO₂ and release of O₂. Normally, most of the plants uses C₃ or C₄ photosynthetic pathways which results in O₂ production only during day. Only CAM photosynthetic pathway (followed by xerophytes and epiphytes) produce O₂ both during day and night. Now, peepal tree being a hemi-epiphyte and one of the largest trees around is responsible for maximum air purification. Peepal too is a veritable storehouse of pure air, emitting oxygen round-the-clock. If there is no Peepal tree around the house horticulturists

suggest that it would be beneficial to keep a couple of Peepal plants in pots, inside or outside the house, to rid the interiors of pollution.

NEEM TREE

Azadirachta indica or neem releases more quantity of oxygen. It has good medicinal value. Its seed and leaves are natural pesticides. According to T.V. Sairam, author of the bestselling book, Home Remedies (Penguin publication), "Neem is a dedicated air-purifier and releases pure oxygen replacing toxic carbon gases. Neem is unique in the sense that it gives more oxygen compared to other.[6,7]

HOLY BASIL

Ocimum sanctum(tenuiflorum) or Tulsi (Basil) too is a very environment-friendly plant Besides, it cures stress and enhances physical endurance. Medicines are made from the extract of its leaves, seeds & roots. It is one of the best medicinal plant called *mother medicine of nature* which can be easily grown in balconies with little care and maintenance. This is a shrub and is highly effective air purifier. The plant also helps in improving the quality of air. The plant can be potted in simple pots or specially designed pots for the purpose. As the plant requires ample sunlight for its growth, the best place to keep the plant is in the balcony where there is enough sunlight. Regular watering of the plant without excess watering helps in the healthy growth of the plant. There are many benefits of Tulsi plant.

MONEY PLANT

This is one of the most commonly found and grown indoor plants in India. Botanically known as *Epipremnum aureum*, the plant is a powerful air purifier and helps in cleaning the air around you. The plant can be easily grown under all conditions. It can be placed in earthen pots or you can also place these in decorative glass bottles and place in any nook and corner of the house. This not only purifies the air but also enhances the beauty of your home. The plant doesn't need much maintenance.[1]

BAMBOO PALM

The plant is also known as butterfly palm and Areca palm. Its botanical name is *Chrysalidocarpus lutescens* and it very much resembles a coconut tree and can easily grow indoors. The another commonly grown indoor plant and is an effective air purifier. Besides purifying the air, the plant is a natural humidifier and helps in maintaining the humidity of air. The plants don't need direct sunlight and the leaves turn yellow on exposure to direct sunlight. The plant grows taller, so you can stunt the growth by placing it in small pots to make the roots crowded. These plants are natural purifier and also natural humidifiers. It is useful in filtering the toxins from the air particularly the cigarette smoke and thus keeps the air pure. The plant needs enough water for its growth and can be placed in the corners of spacious halls / rooms.[2]

SNAKE PLANT

Also known as mother-in-law's tongue and Saint George's sword, the botanical name of this plant is *Sansevieria trifasciata*. It has long tongue-like leaves with patterned scales on it that resemble the scales on the of a snake. The thick leaves shoot upwards giving a beautiful look. The plant can be places in bathrooms as it filters out formaldehyde. It is one of the best air-purifying plants and can be easily grown indoors. It produces abundant oxygen during night, so can be placed in the corners of bedrooms too. It doesn't require any extra care and can survive for a long period even without watering.

SONG OF INDIA

Dracena reflexa or the Song Of India have long blade like light green leaves with lime yellow border. These plants can be easily grown indoors in low light. These absorb all the undesirable gases from the atmosphere and thus keep the indoor air pure.

ORCHIDS

There are different varieties of orchids which not only enhance the beauty of your home but also fill the air with natural fragrance. As these plant don't need direct sunlight, you can place these in any corner your house. With these plants you can get rid of the pollutants like xylene that are found in glues and paints. Orchids are wonderful indoor plants that are great for bedrooms as these add beauty to the room and also fills the air with oxygen.[3]

SPIDER PLANT

Chlorophytum comosum or spider plant derived its name from its uniquely shaped dangling leaves that gives the look of spider's legs. These lovely plants are one of the extensively used indoor plants which gives beauty to the room and also helps in combating unwanted gases like carbon monoxide etc.

ALOE VERA

Aloe vera one of the excellent plants used in skin care product is extensively grown in every house. These plants can be easily grown in mild sunlight and can survive for long even without watering. This is one of the best indoor plants that needs less maintenance and helps in absorbing toxins from the air.

Besides the above mentioned air purifying indoor plants, there are other indoor plants too which are good airpurifiers. These include English ivy, Weeping fig, Peace lilies, *Philodendron*, *Massangeana-cane*, *Pothos*, *Anthurium*, *Schefflera* and of course the bamboo plant in small glass containers used as a Feng shui product.

DISCUSSION AND CONCLUSION

Plants are used as an efficient cleaning system for the environment in a process known as "Phytoremediation", which can be done via various techniques in which plants clear the environment from pollutants. Indoor plants are considered to be natural air filters as they can purify air through different methods: absorption, dilution, precipitation, and filtration. A well-known process carried out by plants is photosynthesis in which plants clean the air through taking in carbon dioxide and releasing oxygen. Respiration is another process where plants absorb oxygen and release carbon dioxide. Through photosynthesis and respiration, the air goes in and out from the stomata, as they are considered the main apparatus that plants use in the absorption and filtration mechanisms. Plants can absorb airborne molecules and restore the ecological balance in the air. In addition, plants can purify the air from pollutants such as carbon dioxide, volatile organic components (VOC), carbonyl, particulate matter, organic compounds, nitrates, sulfates, ammonia, calcium, ozone, and carbonate. Indoor plants can be considered as a low-cost solution that reduces the levels of indoor pollutants and minimize human exposure to many harmful compounds.[5]. Plants can release in the air small quantities of secondary metabolites and their derivatives, such as polyphenols and alkaloids. This process is considered one of the plant's techniques to interact with the surrounding environment called Allelo chemicals. Those compounds were reported to have antimicrobial activities and can interact with airborne microbes close to the plant

Table-1: Plants that have been tested to reduce airborne pathogens and pollutants

Botanical Name	Common Name	Family	Pathogen	Indoor Pollutants
<i>Ficus benjamina</i>	Weeping Fig	Moraceae	Bacteria, Actinomycetes and Mold	Formaldehyde, VOCs
<i>Ficus alii</i>	Alli Ficus	Moraceae	Bacteria, Actinomycetes and Mold	
<i>Spathiphyllum sp.</i>	Peace Lily	Araceae	Bacteria, Actinomycetes and Mold	Benzene
<i>Chrysolidocarpus lutescens</i>	Areca palm	Arecaceae	Bacteria, Actinomycetes and Mold	Formaldehyde, Total Volatile Organic Compounds(TVOCs), CO ₂ , CO
<i>Dracena fragrans Massangeana</i>	Corn plant	Asparagaceae	Bacteria, Actinomycetes and Mold	Benzene, ozone, Toluene ,Xylene and Formaldehyde , Tri-chloro ethylene
<i>Dracena dermensis</i>	Warneckii	Asparagaceae	Bacteria, Actinomycetes and Mold	Benzene, ,Toluene ,Xylene and Formaldehyde ,ethylbenzene
<i>Deiffenbachia [Exotic compacta]</i>	Dumb cane	Arecaceae	Bacteria, Actinomycetes and Mold	Toluene ,Xylene
<i>Deiffenbachia camille</i>	Dumb cane	Arecaceae	Bacteria, Actinomycetes and Mold	Toluene ,Xylene
<i>Rhapis excelsa</i>	Lady Palm	Arecaceae	Bacteria, Actinomycetes and Mold	Formaldehyde
<i>Philodendron domesticum</i>	Philodendron	Arecaceae	Bacteria, Actinomycetes and Mold	Formaldehyde
<i>Epipermum aureum</i>	Golden pothos	Arecaceae	Bacteria, Actinomycetes and Mold	Benzene
<i>Syngonium podophyllum</i>	Arrow head vine	Arecaceae	Bacteria, Actinomycetes and Mold Bacteria, Actinomycetes and Mold	CO ₂ , VOC, Benzene
<i>Sansevieria frifaciata [Laurenatii]</i>	Snake plant	Asparagaceae	Bacteria, Actinomycetes and Mold	Ethylbenzene
<i>Codiaeum varigatum</i>	Croton	Euphorbiaceae	Bacteria, Actinomycetes and Mold	Toulene
<i>Cyperus alternifolius</i>	Umbrella grass	Cyperaceae	Bacteria, Actinomycetes and Mold	

Alpine air- Conifers, like Pines and Cypresses, are also good natural purifiers. In 2015, Jun Yang, an urban ecologist at the Centre for Earth System Science, Tsinghua University, in Beijing, ranked the most frequently occurring species in cities based on their PM 2.5 absorption capacity. The ranking also took into account species' ability to survive in urban contexts, and any negative impact on air quality, such as the production of allergens, and of volatile organic compounds (VOCs) – a set of substances that can interact with gases emitted by vehicles, like nitrogen dioxide. In the presence of sunlight, these reactions can contribute to ground-level ozone, which is harmful to human health. The effects can be considerable; when a heat wave hit Berlin in 2006, the ozone created by the interaction of plants' VOCs and vehicles' pollutants resulted in sudden decreases in air quality.[15,16]

The reason for conifers' success in reducing PM is partly down to their canopy structure – the dense canopy of needle-like leaves typical of conifers is very effective at trapping pollutants. And their seasonal biology helps too. "Conifers offer the best PM reduction because they are an evergreen species," Nowak says. Unlike deciduous trees, which lose their leaves during winter, evergreen species act as year-round filters. "But that does not automatically make them fit for any context." [17,18]

Trees can improve air quality in direct and indirect ways. Indirectly, they can help by shading surfaces and reducing temperatures. If buildings are shaded by trees, it reduces the need for conventional air conditioning, and the emissions of greenhouse gases that come with it. Plus, lower temperatures decrease risk of harmful pollutants like ground level ozone that commonly spike on hot days in urban areas. From an urban planning perspective, plants act as a readily available set of particulate matter [PM] purifiers. "Trees can help reduce PM in two main ways," says Prashant Kumar, the founding director of the Global Centre for Clean Air Research at the University of Surrey.[19,20]

The first one is dispersion – by crashing into trees and plants, concentrated clouds of minuscule particles get dispersed and so diluted by the air, decreasing the risk of inhalation by humans. The second one is deposition. PM can easily get trapped in the waxy, hairy leaves of trees and shrubs. When it rains, most of these particles are washed away by water into drains.[8]

"The extent to which each species performs such filtering activity depends mostly on canopy size, leaf size and leaf structure," says Baraldi. Bigger canopies can trap more particles than smaller ones, and larger leaves can trap more pollutants than small ones. When it comes to leaf type, it is those with rough, rugged and hairy surfaces that act as the "best filters" for PM.[13,14]

Recent research suggests that tiny hairs on plant leaves in particular may play a big role in trapping the solid and liquid particles that make up PM. In one recent study, Barbara Maher and colleagues at the University of Lancaster tested the ability of nine tree species to capture PM in wind-tunnel experiments. Silver birch, yew and elder trees were the most effective at capturing particles, and it was the hairs of their leaves that contributed to reduction rates of 79%, 71% and 70% respectively. In contrast, nettles emerged as the least useful of the species studied, though they still captured a respectable 32%. [9,10]

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Fine particulate matter can easily penetrate into human respiratory system, causing lung and cardiovascular diseases or exacerbating respiratory illness. It has also been linked to inflammation and heart disease. By one estimate, 8.9 million deaths a year globally could be attributable to exposure to outdoor fine particulate matter.

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Trees also play a vital role in directly removing pollutants from the air. Plants are often seen as the "lungs" of an ecosystem because they absorb carbon dioxide and emit oxygen, says Rita Baraldi, a plant physiologist at the Institute of Bio economy of the Italian National Research Council. But they also act as an ecosystems "liver" too, filtering atmospheric pollutants like sulphur dioxide and nitrogen dioxide through their leaves.[7,8].

Thus this reviewed paper will help students to know the importance of trees. They can study anatomy and morphology of plants as to know how they absorb the particulate matter and help in phytoremediation.

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