

Indoor medicinal plants: Beneficial biocatalysts for air filtration and bioremediation – A review

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Abstract

The development of technology enhances the need for eco-friendly measures to improve the quality of life. Plants are the natural bioreactors that have to be explored for their resourceful applications. Some of the significant indoor medicinal plants with high environmental values are Areca palm, *Aloe vera*, English ivy, Spider plant, and Bamboo palm. These indoor plants through their natural mechanisms possess a unique property of air filtration. They filter out air pollutants such as benzene, xylene, toluene, formaldehyde, and other chemicals that produce deleterious effects, especially in children, pregnant women, and aged people. They further degrade waste and reduce pollution through bioremediation. These plants also possess bioactive phytochemicals that enable them to be utilized widely for therapeutic, commercial, and industrial purposes. This review describes these five plants as natural air purifiers, along with their medicinal values and other benefits, emphasizing their significant biocatalytic role in bringing forth a clean and healthy environment.

Key words: Air filtration, *Aloe vera*, Areca palm, Bamboo palm, Bioremediation, English ivy, Spider plant

INTRODUCTION

In the current scenario, air pollution is a noteworthy raising danger. It poses to be a major threat to humans and causes several diseases and deaths.^[1] Children and old people are largely vulnerable. Air is infected both by natural and artificial sources. Air is mostly contaminated by industries and transportation.^[2] Air toxins explicitly ozone, carbon monoxide, nitrogen oxides, sulfur oxides, and smoke particles are highly hazardous.^[3] Volatile organic compounds (VOCs) such as benzene, toluene, and xylene are responsible for the majority of air pollution.^[4]

The impure air can be expelled by natural resources available in the environment. Earth is provided with air-filtering plants that can be grown indoor.^[5] Nature has bestowed on these plants special cellular structures and physiological processes that equip them in bioremediation. Plants usually convert carbon dioxide into oxygen through photosynthesis. Using this process, these natural air filters, also help in the removal of other unwanted chemical molecules from the atmosphere.^[6] Further, they can metabolize and destroy or convert toxic pollutants to nontoxic compounds

through phytodegradation or phytotransformation. They also release nutrients to the soil microorganisms and enable rhizosphere biodegradation. The bioavailability of pollutants is reduced by immobilization through phytostabilization. Phytoextraction is also adopted to remove the contaminants.^[7]

Indoor pollutants are more hazardous as they directly affect the lungs. According to a report, every year in India, 496,000 in rural areas and 93,000 in urban areas die due to indoor air pollutants. Indoor air pollution can be eliminated through source control, adequate ventilation, use of air filters, and indoor plants. However, the most practically applicable and less expensive way is to grow indoor plants with natural air filtering mechanisms.^[8]

It has been found by the National Aeronautics and Space Administration (NASA) that VOCs in closed environments

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such as International Space Stations can be filtered by such house plants. The air pollutants are taken up by these plants through leaves and translocated to the roots. The hazardous chemicals are further filtered through several biological mechanisms.^[9] They include processes such as microbial degradation by rhizospheric microorganisms, plant-liquid extraction by phytoextraction, plant-gas extraction by stomatal uptake, direct evaporation or indirect transpiration from leaves, and enzymatic catalysis within tissues.^[10]

Photosynthesis is another natural mechanism by which plants can remove carbon, nitrogen oxides, sulfur oxides, ammonia, and other chemicals responsible for smog and greenhouse effect.^[6] Hydrophilic VOCs are easily processed than the lipophilic ones by the indoor plants. It has been found that about an average of 107 microbes residing on 1 cm² area of leaf, feed, and eliminate impurities from leaf exudates. Volatile impurities get deposited on plant surfaces like leaves, absorbed by the cuticle at the upper side of the leaves, and taken up by stomata if small enough to pass through the stomatal cavity by diffusion.^[11]

Relative humidity increased by the house plants assist in reducing particulate pollutants. Air-borne microbes and mold spores in the air can be eliminated by the volatile phytochemicals released by these plants. According to the NASA report, VOCs are also sequestered within these plant cells, converted to safer compounds, and are degraded by microorganisms attracted by their roots which consume them for their food and energy.^[9,12]

The environment can be cleaned by indoor houseplants.^[9] These plants can be utilized to refine air and help humans to inhale the crisp air. They can be easily maintained at home and are economical. They possess significant medicinal properties and find wide applications. This review is on five such plants, namely, Areca palm, *Aloe vera*, English ivy, Spider plant, and Bamboo palm. Figure 1 pictures these air-purifying medicinal indoor plants.



Figure 1: Air purifying medicinal indoor plants (a) Areca palm^[29] (b) *Aloe vera*^[42] (c) English ivy^[42] (d) Spider plant^[6] (e) Bamboo palm^[104]

ARECA PALM

Description

Areca palm is otherwise called a brilliant stick palm, yellow palm, and butterfly palm.^[13] It belongs to the type of blossoming plant.^[14] Researchers guarantee the plant as the best air decontaminating plant.^[15] It is found in the regions of Madagascar and South India.^[16]

The indoor height of the areca palm can be in the range of 6 to 12 feet.^[17] Numerous stems rise out of the base. The inflorescence can be spadix or spike.^[18] The leaves are curved and pinnate. The plant bears panicles of yellow blossoms in summer.^[19]

Bright sunlight suits areca palm, but too much of it can harm the leaves. The plant grows well in moderate temperature and does not require much water.^[6]

Scientific Classification^[20]

Kingdom: Plantae
Clade: Angiosperms
Clade: Monocots
Order: Arecales
Family: Arecaceae
Genus: *Dypsis*
Species: *lutescens*

Air Filtration

Areca palm has the unique property to sort out air contaminants such as toluene, xylene, and acetone which produce malicious impact.^[11] It is also demonstrated to filter chemicals such as formaldehyde, benzene, and trichloroethylene from nature.^[21] This plant is found to transpire 1 l of water/day through which also the contaminants can be eliminated.^[22]

The leaves, roots, soil, and related microorganism of the plant have been assessed for decreasing the air toxins.^[23] The plant parts and the associated microbes are found to help in the conversion of the air pollutants to less or non-toxic molecules.^[24]

Pharmacological Properties and Therapeutic Values

The Arecaceae family has enormous chemical compounds such as diterpenes, triterpenes, flavonoids, saponins, steroids, and alkaloids.^[25] Phenolics, a category of phytochemicals present in areca palm, possess therapeutic value against atherosclerosis and cancer.^[26] This plant has antioxidant and radical scavenging properties.^[27] It is used in the treatment of respiratory problems.^[28] It protects the nervous system and

prevents necrosis in children as it helps in removing toluene which can be harmful to the central nervous system.^[29]

Other Applications

Areca palm has extraordinary economic significance by providing coconut items, wine from its sap, milk, oil, dates, palm syrup, ivory nuts, carnauba wax, rattan stick, raffia, and palm wood.^[30] Besides acting as an indoor air purifying plant, areca palm can be used as an ornamental plant.^[31]

ALOE VERA

Description

Aloe vera is a succulent plant.^[32] It is also known as a wonder plant.^[33] It grows in the regions of Africa, Asia, Europe, and America.^[34] It has mainly originated from the Arabian Peninsula.^[35] The plant is utilized for over 6000 years. It is considered as an indoor air decontamination plant.^[36]

A. vera is a stemless plant. The leaves of the plant are thick as they are composed of three layers, namely, inner gel, yellow sap, and outer thick layer.^[37] The plant grows 60–100 cm tall.^[38] There are over 500 species available in the *Aloe* genus.^[39] Due to its uniqueness, *A. vera* is named as “The plant of immortality.”^[40]

Scientific Classification^[41]

Kingdom: Plantae
Clade: Angiosperms
Clade: Monocots
Order: Asparagales
Family: Asphodelaceae
Genus: *Aloe*
Species: *vera*

Air Filtration

As per the scientists, a pot of *A. vera* is superior to nine air purifiers. Under the 24 h light illumination, it can expel 90% of the formaldehyde, xylene, dust, and harmful microbes in the air.^[42] It can absorb pollutants such as benzene and formaldehyde which are the byproducts of paint and chemical-based industrial products.^[8] It can also filter ethylbenzene and toluene that contaminate air.^[43]

A. vera follows the Crassulacean Acid Metabolism (CAM) pathway to exchange air.^[12] Being a potted plant, *A. vera* favors the rhizospheric microbial degradation of indoor air pollutants.^[10]

A. vera is unique for its “nocturnal breathing.” During the process which occurs in night, the plant takes in carbon

dioxide and releases oxygen. Thus, the plant is the best air purifier at night and can be apt for bedroom. Thus, it is listed under “oxygen bomb” plants. It is a succulent, requires less water and hence can survive even in dry conditions. Further, it is also the best choice to be placed near a kitchen window that receives direct sunlight.^[6,12]

Pharmacological Properties and Therapeutic Values

A. vera is considered to be a medicinal plant. It is utilized in the production of ointment, tablet, and capsules.^[44] *A. vera* lotions are used to prevent radiation-induced skin complications.^[45] The plant has antioxidant, anti-inflammatory, antiulcer, anticancer, antidiabetic, antihelminthic, antiaging, antiseptic, antifungal, and antibacterial activities.^[46] It can be used to treat wound burns and canker sores.^[47,48] The latex of this plant has compounds such as anthraquinones that can heal and reduce pain in teeth and gums.^[49] It can be utilized in the treatment of constipation and irritable bowel syndrome.^[50,51] It can also be used in the treatment of Human Immunodeficiency Virus (HIV) positive people.^[52] *Aloe* juice can reduce stress. It is used for the control of depression, anger, and stability management.^[53] It has an effective therapeutic value against atherosclerosis, coronary heart disease, and liver problems.^[54,55]

Other Applications

A. vera has wide applications in the cosmetics and pharmaceutical industries.^[56] It can be used to make soaps, moisturizer, sunscreen, and shampoo.^[57] It is also used in the food industry.^[58]

ENGLISH IVY

Description

English ivy is known as a versatile house plant.^[59] It is found in the regions of Europe, Western Asia, and Northern Africa.^[60] There are about 16 different varieties of species of this plant.^[61] It is also called as European ivy and as an indoor air filtering plant.^[62]

English ivy is a climbing plant.^[63] The stems are woody with a 25 cm diameter. The leaves are alternate, exstipulate, petiolate, glabrous, and coriaceous.^[64] It is a flowering plant. It also bears fruits.^[65]

Moderate sunlight and temperature are sufficient for English ivy, making it easy to grow.^[6] It is a shade vine and can survive even in dark rooms and newly renovated buildings. Care should be taken to keep it out of reach of children as its leaves are poisonous.^[42]

Scientific Classification^[66]

Kingdom: Plantae
 Clade: Angiosperms
 Clade: Eudicots
 Order: Apiales
 Family: Araliaceae
 Genus: *Hedera*
 Species: *helix*

Air Filtration

English ivy helps in the removal of benzene, xylene, toluene, formaldehyde, ammonia, and hydrocarbons.^[67] It is also used to reduce mold.^[68] The plant can filter indoor air pollutants with the help of soil, roots, and microorganisms.^[69] It also utilizes photosynthesis to convert harmful chemicals into harmless substances.^[9]

Pharmacological Properties and Therapeutic Values

English ivy is one of the indoor plants with very good medicinal properties.^[70] In early times, Hippocrates used this plant to prevent intoxication and decrease swelling.^[71] It is used to treat respiratory problems such as asthma, bronchitis, and also arthritis. It has antioxidant, antiviral, antitumor, antibacterial, antihelminthic, leishmanicidal, antispasmodic, antifungal, and anti-inflammatory activities applied in the medical field.^[72] It is also used as an anesthetic.^[73-75] Triterpenoids, saponins, flavonoids, and alkaloids are the phytochemicals present in this plant which add to its medicinal value.^[76]

Other Applications

English ivy is best known as a decorative plant.^[63] It finds wide application in pharmaceutical industries.^[77]

SPIDER PLANT**Description**

Spider plant is otherwise called ribbon plant.^[78] It is a perennial rhizomatous herb.^[79] It is local to Southern Africa, Western Africa, Central Africa, Eastern Africa, and Southeast Asia.^[80] There are about 234 varieties of species of this plant in the world.^[81]

The height of the spider plant is 5 feet. It has long, narrow leaves.^[82] The flowers are small and white with three to six petals.^[83]

Scientific Classification^[84]

Kingdom: Plantae
 Clade: Angiosperms
 Clade: Monocots
 Order: Asparagales
 Family: Asparagaceae
 Genus: *Chlorophytum*
 Species: *comosum*

Air Filtration

The leaves of the plant have a high tendency of absorption of chemicals such as formaldehyde, carbon monoxide, benzene, trichloroethylene, and phenols.^[85,86] The absorbed pollutants are converted into organic molecules with the help of the associated microorganisms.^[87]

Spider plants have been reported to filter off 95% carbon monoxide and 85% formaldehyde from air within 24 h. They are also effective in removing carcinogenic chemicals like nicotine prevailing in cigarette smoke.^[42] They also eliminate particulate pollutants in air.^[87] They can also be grown in small garages and industries as they remove harmful chemicals released into air from leather and rubber.^[6]

Pharmacological Properties and Therapeutic Values

Spider plant is utilized for the treatment of bronchitis and fractures.^[88] It has important constituents such as saponins, proteins, carbohydrates, vitamins, minerals, steroids, and flavonoids.^[89] The root extract of this plant is used to decrease the inflammation processes in the liver and helps in the process of healing.^[90] It also possesses antiproliferative activity.^[91] The plant is also used to treat cough, wounds, and headaches.^[92]

Other Applications

Spider plant is used as an ornamental plant.^[93] This plant has the unique ability to generate bioelectricity.^[94]

BAMBOO PALM**Description**

Bamboo palm is otherwise called reed palm, clustered parlor palm, and cane palm.^[95] Bamboo palm is inherent to Southern Mexico and Central America.^[96]

The height of the mature bamboo palm is 4–12 feet.^[97] The stem is long and slim.^[98] The leaf has 10–14 pinnate. They

have yellow male and female blossoms. The fruit is orange in color.^[99]

Scientific Classification^[100]

Kingdom: Plantae
Clade: Angiosperms
Clade: Monocots
Order: Arecales
Family: Arecaceae
Genus: *Chamaedorea*
Species: *costaricana*

Air Filtration

Bamboo palm is used for removing many harmful chemicals such as toluene, benzene, and formaldehyde.^[101] Bamboo palm helps to keep the air moist.^[102]

Wolverton reported through his experimental analysis that bamboo palm of total leaf surface area of 10,325 cm² removed 16,520 and 34,073 micrograms of trichloroethylene and benzene, respectively, over an exposure period of 24 h. Similarly, 14,205 cm² total leaf surface area of this plant in 24 h, removed 76,707 micrograms of formaldehyde. Microorganisms in the soil of the plant genetically adapted when exposed to such toxic chemicals and converted them to food sources.^[102]

Pharmacological Properties and Therapeutic Values

Bamboo palm is considered as a natural humidifier.^[103] This plant has the ability to absorb toluene, so it can be used to treat eye, nose and throat irritations, unsteadiness, neurological, and visual problems.^[104]

Other Applications

Bamboo palm is a well-known decorator and utilized as an ornamental plant.^[105]

CONCLUSION

Areca palm, *A. vera*, English ivy, Spider plant, and Bamboo palm are all highly valuable medicinal indoor plants. Besides adding an aesthetic sense to the environment, they effectively remove hazardous chemicals. They serve as potent therapeutic plants with multipurpose applications. Thus, these plants with all their remarkably significant attributes serve as promising resources for supporting health and environment towards sustainable development.

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