

Plants for Improving Indoor Air Quality

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Abstract: Modern-day commercial and residential buildings are energy saving and air tight constructions, these constructions lead to the accumulation of air pollutants to dangerous levels, posing a threat to human health. Potentially toxic gases and particulate matter (PM) are often released by a spread of indoor sources and activities of occupants, including furnishings, paints, varnishes, waxes, carpets, solvents, cleaning supplies, office equipment like copiers and printers, gas cooktops, and cigarettes [2]. Air pollutants common to different indoor environments include carbon monoxide gas and dioxide (CO and CO₂), volatile organic compounds (VOCs; e.g., formaldehyde and benzene), nitrogen oxides (NO and NO₂), and polycyclic aromatic hydrocarbons (PAHs). Plants can absorb and catabolize almost any airborne pollutant; they can improve indoor air quality (IAQ) by simultaneously taking up CO₂ and releasing O₂ and increase air humidity by transpiration.

Keywords: Absorption, Adsorption, Anatomy, Biosystems, Heating Ventilating & Air conditioning (HVAC) systems, Indoor Air Quality (IAQ), Morphology, Phytoremediate, Stomata, Sustainable, Volatile Organic Compounds (VOCs).

1. Introduction

Modern days commercial and residential buildings consume approximately 30% of total global energy. So to save energy, thermally insulated buildings are being constructed which require less energy for heating, ventilating, and air-conditioning (HVAC) systems. People in industrialized countries spend more than 80% of their lives indoors, that's leading to respiratory and cardiovascular diseases eventually contributing to the so-called 'sick buildings syndrome' and 'building-related illnesses'(BRI). So there is a need for the development of modernized self-sufficient bio systems, which is a combination of best-performing indoor plant species with new air-cleaning technologies, which will represent an economical solution to improve the quality of life of people living in 'smart' and more sustainable buildings[1].

2. Greening the Great Indoors

Having plants in the home is an important component of creating a sustainable indoor ecology, a healthy mind, and body. Indoor plants improve the air quality by removing Carbon dioxide, volatile organic compounds, particulates, formaldehyde, and benzene. Room humidity can increase from 20% to a more comfortable 30% in the presence of indoor plants, under bright light conditions. Plants stimulate both

physiological and psychological relaxation responses.

3. Plants- Phytoremediate the Indoor Air Pollutant

Plants can improve indoor air quality (IAQ) by the method of simultaneously taking up CO₂ and releasing O₂ through light-dependent photosynthesis, and increases air humidity by water vapor transpired from leaves through microscopic leaf pores, namely stomata. Plants can regulate stomatal apertures in response to variable environmental conditions (i.e., light availability or air humidity) through a signaling network of hormones (i.e., abscisic acid, ABA) that are exchanged between roots and shoots, actively [1].

Non-stomatal adsorption- Indoor air pollutants were collected on the external surfaces of the entire root-soil system of the plant, passively. Total area, anatomical features, morphological traits, and chemical properties of the plant surface can affect the non-stomatal adsorption. Various factors like leaf shape and density of trichomes affect the capacity of the leaf to adsorb the indoor air pollutants [3].

Stomatal absorption- Stomatal absorption is 30–100 times higher than non-stomatal adsorption [4]. After entering the plant leaves, some pollutants are degraded metabolically and/or translocated to shoots and roots. Plants have enzymes that can readily catalyze the degradation of pollutants, like the oxidation of formaldehyde or the hydroxylation and cleavage of the aromatic rings of benzene and toluene. After being catabolized, the assimilated pollutants were reemitted into the air or ejected via root exudates or further metabolized to be used as carbon and energy sources.

4. Selection of Indoor plants

- Besides considering the aesthetic features, good survival, and low maintenance needs there is a need to outline the scientific criteria's such as morphological, anatomical, and physiological properties that reflect the capacity of the plant to phytoremediate the air pollutants. Through non-stomatal adsorption plant microbiomes, remove the airborne pollutants actively.
- By discovering various metabolic pathways, enzymes, and genes involved in air phytoremediation, will enable the determination of biomarkers for identifying and thereby phenotyping the appropriate plant species for improving IAQ.

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- Genetically modified plants can be produced by editing the genome of plants through precise and targeted DNA modifications aimed at overexpressing or inserting genes encoding detoxification enzymes.
- *Osmunda japonica* (Japanese royal ferns), *Chlorophytum comosum* (spider plants), *Nephrolepis exaltata* (Boston ferns), *Hemigraphis alternata* (purple waffle plants), English ivy, areca palms, golden pothos, aloe vera, snake plants, peace lilies, etc. are some of the common used indoor plants.

5. Integrating Plants with Air-Cleaning Technologies

Integrating the indoor plants with modern air cleaning technologies will help in the sustainable and energy-efficient improvement of IAQ. Present times air-cleaning technologies that integrate heating, ventilation, and air conditioning using electro filters, Ultraviolet lights, catalyzers, photocatalytic materials are useful for improving IAQ, but they are often very costly related to frequent maintenance and their significant energy consumption [1].

Usage of biosystems that combine air cleaning technologies with the best indoor plants is more cost-effective and sustainable. The use of the targeted light spectrum required for plants by LED illumination, can enhance the CO₂ assimilation and stimulates the opening of stomata, thereby increasing the absorption of air pollutants [5]. New 'green' indoor environments could be designed only by pursuing an inter-and multidisciplinary approach of using modern technology and understanding the phytoremediation capacity of indoor plants

with their associated microbiomes.

6. Conclusion

The use of indoor plants to phytoremediate indoor air pollutants has been overlooked. While selecting indoor plants, instead of considering only the aesthetic features, considering the scientific criteria like their capacity to phytoremediate the air pollutants is essential. The development of eco-sustainable, cost-effective (and possibly self-sufficient) plant-based bio systems ready to enhance IAQ, will positively affect both human society and therefore the construction industry in a novel fashion that could lead to a postmodern version of eco-architecture.

References

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