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Greening the Indoors: The therapeutic impact of interiorscaping on indoor environments: A review

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Abstract

Gardening is an art of growing plants which provides oxygen-rich air, peaceful and calm atmosphere which soothes our soul. Urbanization leads to the reduction in gardening activities in most of the cities. Thus, interior scaping has evolved into a dynamic and innovative field, with trends that cater to our desire for natural beauty, health, sustainability, and simplicity. From the biophilic design principles that foster a connection with nature to the use of vertical gardens and air-purifying plants, the latest trends in interior scaping provide endless possibilities for transforming indoor spaces into inviting and rejuvenating environments. The interior landscape can support environmental sustainability as a key concern within the interior design area since ecological interior design can reduce harmful impacts and boost good benefits on environmental systems over the course of a building's existence. Humans have used technological improvements to enhance the workplace, where they spend the majority of their time away from the outdoors and urban scenery.

Keywords: Interiorscaping, urbanization, air purifying plants, rejuvenating environments

Introduction

Interacting with nature has become essential for improving quality of life and providing numerous tangible benefits to people. In our culture, plants have many spiritual significances, and man is born with plants, lives with plants, and eventually dies with plants. Plants improve the physical, mental and emotional well-being of human beings (Dijkstra *et al.*, 2008) ^[29]. People used to decorate homes from the inside and outside as well to mark special occasions. Thus, a concept of interiorscaping which is the practice of adding biophilic elements to a location, usually one inside a building is gaining momentum nowadays. Creating a beautiful, tranquil indoor environment involves designing and putting in plants, water features, rocks, and other natural components. Chinese culture dates back thousands of years reveals that keeping plants in their homes is a source of harmony and a symbol of richness. Nowadays due to the change in lifestyle and modernization, people spent more time i.e., almost eighty percent in indoor which leads to various health problems to the children as well as elderly people. The living style of urban people have a negative impact on their health (Raymond *et al.*, 2017) ^[15]. Therefore, by incorporating the nature into the interior spaces helps in overcoming the health problems by healing garden, therapeutic garden, water scaping, etc. (Wood *et al.*, 2006) ^[27]. The indoor air quality is getting worse in indoor than outdoor. Plants have been labeled as the "Lungs of cities" (Mcpherson, 2005) ^[5] because they have the ability to reduce pollution. Air pollution has become a necessary evil with rapid industrialization and urbanization (Yang and Liu, 2011). According to the World Health Organization, more than 4 million people died prematurely from illness attributing to indoor air pollution (WHO, 2021). Due to lung cancer (17%) is attributed exposure to carcinogens from household air pollution caused by cooking with solid, stroke (12%), ischemic heart disease (27%) and chronic obstructive pulmonary disease (25%). Indoor air quality (IAQ) has become a grave alarm, as it is two to five times worse than ambient air.

The indoor air pollutants include Volatile organic compounds (VOCs), Particulate matter (PM), Inorganic air pollutants (IAP). Volatile organic compounds include any carbon compound excluding CO₂, CO, carbonic acid, metallic carbides or carbonates, which participate in atmospheric photochemical reactions. (US EPA). The sources may be anthropogenic or biogenic. Anthropogenic (AVOCs) from paint, coating, finishers, paint removers etc. are the sources of acetone. Adhesive mosquito coil and solid fuel are sources for aliphatic hydrocarbons such as formaldehyde, octane, decane etc.

Gasoline and wall coating contributes aromatic hydrocarbons such as xylene, benzene etc. Carpet cleaner, paint remover, dry clean clothes and solvents, lacquers contribute Halogenated hydrocarbons (trichloroethylene) whereas terpenes are from deodorizers, cleaning agents, polishes, softeners, cigarettes etc. Biogenic (BVOCs) includes chloromethane, isoprene and monoterpenes which are from trees and other plants (Harrison *et al.*, 2012) [17].

Air pollution can build up in any confined space and even gases (mainly VOCs) from synthetic materials used now-a-days to construct homes can be resulted in 'Sick building syndrome' (Sarkingobir *et al.*, 2017) [16].

Particulate matter (PM)

Particulate matter (PM) is a mixture of solid and liquid substances with different origins, shapes and chemical compositions. PM (non-reactive part: C or Ca) + Toxic metals and free radicals (EPFRs) are more toxic (Gehling and Dellinger, 2013) [30]. The sources of these particular matter are from outdoors - vehicle exhausts, road dust, fossil fuels, industries where as in indoors - Heating, cleaning and cooking activities.

The particulate matter is classified into four by Gawronska and Bakera, 2015 [4]

Large	Ø: 10–100 µm	PM 10 Mold spores Bacteria Soil dust and smoke
Coarse	Ø: 2.5–10 µm	PM 2.5 Vehicle exhaust
Fine	Ø: 0.1–2.5 µm	Wildfires Power plant emissions Other combustion PM 0.1
Ultrafine	Ø: < 0.1 µm	Printer toner Cooking- combustion Vehicle exhaust

Inorganic air pollutants (IAP)

The most important and common inorganic air pollutants are SO₂, CO₂, CO, NO_x and O₃. Incomplete combustion of wood or burning of fuels such as oil, gas, kerosene, wood, coal or propane generate IAPs. Combustion by-products include carbon monoxide, nitrogen dioxide, carbon dioxide, sulphur dioxide, water vapour and hydrocarbons. The inorganic air pollutants cause headaches, dizziness, restlessness, difficulty in breathing, sweating, tiredness, increased heart rate, elevated blood pressure, heart attack, etc.

All the air pollutants will enter into home or indoor atmosphere through ventilation.

Benefits of interiorscaping

Reduction in air pollutants: Indoor plants can minimize all types of air pollution and provide additional advantages including increased productivity, psychological comfort for individuals and a reduction in stress and bad emotions. Studies conducted over the past three decades have shown that indoor potted plants can dramatically lower the concentrations of the majority of urban air pollutants, including particulate matter, carbon dioxide, carbon monoxide, nitrogen dioxide, ozone and volatile organic compounds (VOC), notably benzene and formaldehyde

(Wolverton *et al.*, 1999 and Orwell *et al.*, 2004) [26, 10].

CO₂ reduction

The effect that plants have carbon dioxide (CO₂) is one of the main reasons that indoor spaces should have plants. One of the gases whose composition changes in indoor settings most quickly as a result of human metabolic processes is CO₂. The effects of increased CO₂ levels in an environment include weariness, impaired perception and sleepiness. Thus, various levels of CO₂ reduction are aided by plants in a bright environment. The plant that reduces the quantity of CO₂ quickly in the environment among the species used is *Ficus sp.* Thus, *Ficus* is the best species to employ in reducing the amount of CO₂ in indoor spaces out of *Dieffenbachia*, *Yucca* and *Spathiphyllum* (Sevik *et al.*, 2017) [17]. Spider plant (*Chlorophytum comosum*) is not able to absorb CO₂ under 300 lux of light intensity but when the light intensity was increased to 700 lux, it reduced a small amount of CO₂ (0.35 ppm). Hence, spider plant is not suitable to use at indoor to reduce CO₂. However, prayer plant (*Maranta leuconeura*) has total reduction of CO₂ being the highest, whether using 300 lux or 700 lux (Suhaimi *et al.*, 2017) [22].

Reducing particulate matter

Urban residents spend at least 80 percent of their time indoors at home, at work, at school or when engaged in leisure activities. The prolonged exposure to indoor PM_{2.5} particles poses a serious threat to the public's health. Cloth filters, which are incorporated into mechanical ventilation systems are the most commonly used method in commercial buildings. Though residential interior PM_{2.5} can be reduced with portable, high-efficiency particulate air filters, it is an expensive method. Among *Chlorophytum comosum*, *Spathiphyllum floribundum*, *Epipremnum aureum*, *Ficus elastica*, *Sansevieria*, and *Aloe vera*, *Epipremnum aureum* eliminated 30 percent of PM_{2.5} when the initial concentration was around 200 g/m³. Thus, *Epipremnum aureum*, with its rough and grooved leaf surface, largest LAI (Leaf area index, 2.27), and powerful humidifying ability, was the best-potted plant for PM_{2.5} sedimentation (Cao *et al.*, 2019) [1].

Removal of benzene: Benzene is one among the significant environmental pollutants which is a volatile organic compound and causes breathing problems in humans (Pollution Control Department, 2007). It is also present as a gasoline compound released by vehicles and cigarette smoke. These benzenes are carcinogenic to humans and also a small amount can pollute water (WHO, 2003) [21]. The elegant and economic method of removing organic pollutants such as hydrocarbons from the environment is phytoremediation (Treesubsuntorn and Thiravetyan, 2012) [23]. However, the efficiency of the plant for removing the organic compound depends on the ability of the plant to tolerate these pollutants. For evaluating the feasibility of plants for treating air containing benzene eight plants were selected viz., *Syngonium podophyllum*, *Sansevieria trifasciata*, *Euphorbia milii*, *Chlorophytum comosum*, *Epipremnum aureum*, *Dracaena sanderiana*, *Hedera helix*, and *Clitoria ternatea* because of their tolerance to toxic compounds. The most efficient plant for removing benzene is non-sterilized *C. comosum* and the removal rate is 1.6 times higher than that of the sterilized ones (Wararat Sriprapat and Paitip Thiravetyan, 2016) [20].

Removal of Formaldehyde

The foliage plants are used in interiorscaping is for decorative purpose as well as for improving the indoor environmental conditions. Formaldehyde is one of the most abundant aldehydes present in indoors ranging from 16–49 ppb, whereas the outdoor level of formaldehyde is rather low (i.e., below 16 ppb) when compared with the indoor level. Eight foliage plants which effectively remove formaldehyde and are used for decorating the indoors were selected which included golden pothos (*Epipremnum aureum*), spider plant (*Chlorophytum comosum*), dumb cane (*Dieffenbachia seguine*), Boston fern (*Nephrolepis exaltata*), aloe vera (*Aloe vera*), snake plant (*Sansevieria trifasciata*), Chinese evergreen (*Aglaonema sp.*), and Spanish moss (*Tillandsia usneoides*) and divided these into strong and weak formaldehyde absorbers. Boston fern (0.85 m h^{-1}) absorbed formaldehyde faster followed by golden pothos (0.41 m h^{-1}), Spanish moss (0.44 m h^{-1}) and spider plant (0.40 m h^{-1}) (Sirima Panyametheekul *et al.*, 2019) ^[11].

Horticultural therapy

Horticultural therapy improves multiple medical condition of patients. Indoor plants reduce the nervousness as well as anxiety (Chang and Chen 2005) ^[2]. It has the potential to reduce stress (Evensen *et al.* 2015) ^[3]. Indoor plants also has the capability to enhance a person's performance and mood (Han 2009) ^[6]. It maintains the working condition of people. The indoor plants can promote human creativity and also the comfortness and attractiveness of the office atmosphere, while at the same time decreasing worker productivity (Raanaas *et al.* 2011) ^[13]. The concept that plants play a role in mental health is well-established. Horticultural therapy is utilised in mental health treatment owing to the therapeutic effects vested with gardening (Söderback *et al.* 2004) ^[19].

Air temperature

Urbanization has some secondary effects on the environment such as increased air temperature which demands for cooling inside the building which leads to high energy consumption (Wang *et al.*, 2016) ^[24]. Utilising green plant walls in indoor reduces the energy consumption and also reduces the heat and temperature which thereby gives a cooling effect (Tan *et al.*, 2016) ^[12].

Aesthetic value

The interiorscaping improves the aesthetic value of the indoor space or the area utilised. Some of the components in an interior scape includes terrariums, bonsais, dish garden, fountains, bottle gardens, aquariums, etc. They plays a vital role in beautifying and creating an attractive mini garden inside the buildings or offices. These are very important in multi-storeyed buildings where outdoor gardens are difficult to create (Singh and Malhotra, 2017) ^[18].

Environmentally friendly interiors

The use of sustainable materials in interior design has gained attraction. Designers are opting for eco-friendly and recyclable materials for planters, containers and other elements of interiorscaping. This trend aligns with the broader goal of creating environmentally conscious and responsible indoor spaces. Studyanto *et al.*, (2021) ^[25] suggested that interior design with ecologically friendly materials has a beneficial influence on energy savings, natural resource

savings, environmental health, and offering comfort for guests. The use of ecologically friendly elements in the interior such as antique furniture and artwork, may also contribute to the place's individuality and character.

Greenery Meets Innovation

The integration of smart technology into interiorscaping has opened up new possibilities. Automated irrigation systems, intelligent lighting solutions and sensors that monitor plant health and environmental conditions have become prevalent. These innovations make it easier to care for plants, optimize resource usage and create an ideal growing environment. Smart technology adds a touch of modernity to interiorscaping while enhancing its efficiency and effectiveness.

Conclusion

Interiorscaping has become a vital part in the urban areas where outdoor areas are scarce. People have started to decorate their homes and offices with indoor plants for aesthetic value as well as for their ability to act as a stress buster, improve air quality and purifying the indoor air, reducing indoor air pollutants improving focus, enhancing personal performances, promoting recovery and uplifting mood. The interiorscaping also have therapeutic nature which is a boon to the people staying alone in houses and hospitals.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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