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Cleanest, Greenest Solution for Maintaining Indoor Air Quality in Urban Areas: Plants

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ABSTRACT

In urban area people spend more than 90 percent of their time in indoors environment. All of these are made worse in small or poorly-ventilated spaces (like maybe your apartment with that window that you accidentally painted shut last year). Researchers find that indoor air can emit contaminants like formaldehyde, xylene, benzene; ozone etc. as outdoor air contaminants like car exhaust finds its way into buildings. These cause serious health problem to mankind. NASA scientists have been research to overcome these problem and they find that cheapest, greenest solution for cleaning of contaminated indoor air in urban environment is plants. A beautiful potted plant is much more attractive and discrete than our average air filter. They enhance the look and feel of our home or office. This study has been focus on indoor plants and their air cleaning abilities.

Keywords: *Indoor air, Contaminants, Cheapest and Greenest solution, Plants*

Introduction:

In urban areas indoor air pollutants have been ranked among the top five environmental risks to public health. In these areas stagnant indoor environments and lacking decent ventilation can cause "**sick building syndrome**".

Symptoms of Sick Building syndrome

NASA astronauts experience sick building syndrome all the time in their sealed space stations. Sick building syndrome occurs when people who work or live inside a building experience symptoms such as:

*Headaches
*Nausea
*Irritation in the eyes, throat or nose
*coughing
*Dry and itchy skin
*Inability to focus
*Allergies

These symptoms usually go away when we leave the building for a certain amount of time. While the cause is unknown, sick building syndrome is known to reduce productivity.

These conditions allow pollutants to build up and stick around in greater amounts than we humans should be breathing in.

Major indoor pollutants present in our home

a. **Benzene** – Can be found in Glues, paints, furniture wax and detergents.
b. **Formaldehyde** – Is in emissions, disinfectants and fixatives, or preservatives in consumer products.
c. **Trichloroethylene** – In homes undergoing renovation.
d. **Xylene and Toluene** – In a variety of household sprays and consumer products
e. **Ammonia** – Aerosols and sprays used in the home.

Living and working in places with these air contaminants can cause headaches, dizziness, nausea, and eye, ear, and nose irritation (Table I and II).

Plants as air purifier: The **NASA Clean Air Study (**Annexure- I) was led by the National Aeronautics and Space Administration (NASA) in association with the Associated Landscape Contractors of America (ALCA). Its results suggest that certain common indoor plants may provide a natural way of removing toxic agents such as benzene, formaldehyde and trichloroethylene from the air, helping neutralize the effects of sick building syndrome (Table1and 2). NASA researchers suggest efficient air cleaning is accomplished with at least one plant per 100 square feet of home or office space. Other more recent research (Höppe and Martinac. 1998) has shown that micro-organisms in the potting mix (soil) of a potted plant remove benzene from the air, and that some plant species also contribute to removing benzene (Table-I and II). Science Daily. February 20, 2009. Quote: "...Complete plants removed approximately 80% of the formaldehyde within 4 hours. Control chambers pumped with the same amount of formaldehyde, but not containing any plant parts, decreased by 7.3% during the day and 6.9% overnight within 5 hours (Kim et al. 2008). Although house plants may be intimidating to those with a "black thumb" or fear of commitment, it turns out that many plants are easy to care for—so easy".

List of Some important indoor air purifier plants:

The first list of **air-filtering plants** was compiled by NASA as part of a clean air study published in 1989, (Wolverton, 1984, 1989 and 1994) which researched ways to clean air in space stations. As well as absorbing carbon dioxide and releasing oxygen, as all plants do, these plants also eliminate significant amounts of benzene, formaldehyde and trichloroethylene (Table III). The second and third lists are from Wolverton and Wolverton (1993) and *Wood, et al. (2004)* and focus on removal of specific chemicals. There are many more plants that can make home look and beautiful, fresh and healthy by providing natural air filters and increasing the oxygen levels.

Tip recommended by NASA: You have between 15 and 18 plants in your home to purify the air you breathe

SOME COMMON AND EASILY AVAILABLE INDOOR PLANTS

Epipremnum aureum **(Devil's Ivy)**

Chrysanthemum morifolium **(Florist's Chrysanthemum)**

Spathiphyllum **(Peace Lily)**

Dracaena reflexa **(Red-Edged Dracaena)** ***Sansevieria trifasciata*** **(Snake Plant)** ***Gerbera jamesonii*** **(Barberton Daisy)** ***Chlorophytum comosum*** **(Spider Plant)**

(Most efficient air freshner according to NASA)

Chamaedorea seifrizii (Bamboo palms) ***Ficus elastic*** **Rubber plants** ***Aglaonema*** **Chinese evergreen** **Aloe Vera**

Process of cleaning indoor air by plant:

By adding a potted plants to a room has been shown to reduce the amount of air particulates. When plants take in carbon dioxide which is then processed into oxygen through photosynthesis. At the same time it also absorbs some of the particulates from the indoor air. Microorganisms associated with the plants are also responsible for much of the cleaning effect. Root-associated microbes convert toxins in the air into nutrients the plants eat and thrive on.

Figure: *Replace air freshener spray with a jasmine plant for healthy breathing air.*

Indoor Plant vs. Other Types of Air Cleaners

a. Plant vs. HEPA Filter

1. Electronic Precipitator efficiency decreases as the collecting plates become loaded with particles or as airflow velocity decreases or becomes less uniform while plants maintains a constant rate of air cleaning indefinitely because it is "self-cleaning". The effectiveness increases over time as the microbes adapt to their environment.
2. Electronic Precipitators need to have their collector plates cleaned regularly exposing the user to a significant amount of toxic build-up. Maintenance of the Plant will not expose the user to concentrated toxin cleaning.
3. Plant is more naturally attractive than any Electronic Precipitator filter unit.
4. Plant will remove Volatile Organic Compounds (VOCs), some of the most dangerous pollutants, whereas HEPA filter (alone) won't.
5. Plant adapts to VOCs and other pollutants over time becoming more effective at eliminating them while HEPA filters slowly lose their effectiveness until renewed by replacing the filters.
6. HEPA usually requires annual replacement of filters, which can cost as much as the filter unit itself, while the indoor plant requires only water, occasional plant food and no filter to replace, ever. Filters contribute to the solid waste stream and expose the user to a substantial concentration of toxins during the replacement process.
7. Indoor plant is more naturally attractive than any HEPA filter unit.

b. Indoor Plant vs. Electronic Precipitator

1. Electronic Precipitator efficiency decreases as the collecting plates become loaded with particles or as airflow velocity decreases or becomes less uniform. Plant Air Purifier® maintains a constant rate of air cleaning indefinitely because it is "self- cleaning". The effectiveness increases over time as the microbes adapt to their environment.
2. Electronic Precipitators need to have their collector plates cleaned regularly exposing the user to a significant amount of toxic build-up. Maintenance of the indoor plant will not expose the user to concentrated toxin cleaning.
3. Indoor plant is more naturally attractive than any Electronic Precipitator filter unit.

c. Indoor Plant vs. Ion Generator/ Ozone Generator

1. Ion/ ozone Generator units emit some ozone which is an irritant gas that reacts with lung tissue and can cause various respiratory irritations, and tends to soil interior surfaces with pollutant particles that are difficult to remove while indoor plant is more naturally attractive than any Ion Generator unit and it gives off only clean air.

The Plant Air Purifier's hydro culture system: Mold, fungus, insects, etc., that can be a problem by infesting the soil of potted plants are less of a concern when growing plants in hydro- culture. When watering plants in hydro- culture, the surface pebbles dry quickly and so do not support the growth of molds and fungus. So the present study deals the listing of virtually-indestructible plants. The Plant Air Purifier's hydro culture system is dozens of times more effective than a single house plant grown in soil. The Plant Air Purifier has been found to remove formaldehyde, benzene, and other volatile organic compounds as well as dust, allergens, and pet dander. It is the cleanest greenest solution for pure, cleaner air. For these purpose NASA calls it "nature's life support system."

Beyond air quality, plants just make people feel better. For example, hospital patients with plants in their rooms were more positive and had lower blood pressure and stress levels. Similarly, indoor plants may make people smarter by allowing them to stay alert and reducing mental fatigue.

Conclusion:

Urban peoples spend about 90% of their time indoors (at home, school or office) (Cavallo, 1997; US EPA 2000; Environment Australia (EA) 2003) where air pollution is typically even higher than outdoors (Brown 1997and EA 2003). Overall study shows that the houseplants can absorb harmful toxins from the air, especially in enclosed apartments with no or little ventilation. This study has been the basis for indoor plants and their air cleaning abilities. While they have less horse power than air purifiers, they're more natural, cost effective, and therapeutic. In the presence of plants, CO_2 levels were reduced by about 10% in offices in the air-conditioned building, and by about 25% in the naturally ventilated building and the CO concentrations were greatly reduced with plant presence, with or without air-conditioning, down to about 8-14% of those in unplanted offices (Tarran et al. 2007).

The indoor plant has several advantages

a. increase mood and productivity
b. enhance concentration and memory
c. reduce stress and fatigue
d. Root-associated microbes convert toxins in the air into nutrients the plants eat and thrive on.
e. The beautiful potted indoor plant enhances the look and feel of our home or office. Hydro-culture, do not support the growth of molds and fungus. So the present study deals the listing of virtually-indestructible plants. While plants have less horse power than air purifiers, they're more natural, cost effective, and therapeutic.

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Table I: Common Indoor Air Pollutants: Sources and Health Impacts

POLLUTANTS FROM NATURAL SOURCES		
Pollutant	**Major Sources in the Home**	**Possible Health Impacts**
Radon – Colourless, tasteless, and odourless gas that comes from the radioactive decay of uranium or radium.	*Earth and rock under buildings *Some earth-derived building *Groundwater; well-water from private supplies	*No immediate symptoms. *Lung cancer- Causes estimated 20,000 lung-cancer deaths yearly. Smokers are at higher risk of developing radon induced lung cancer.
Biological Contaminants– Molds, mildews and fungi, bacteria, viruses, dust, mites	*House dust *Infected humans or animals *Bedding *Poorly maintained humidifiers, dehumidifiers & air conditioners *Wet or moist surfaces *Carpets and home furnishings	*Allergies and asthma *Headaches *Eye, nose and throat irritation *Colds, flu, and pneumonia

Table II: Common Indoor Air Pollutants: Sources and Health Impacts

Pollutants from Man-Made Sources		
Pollutant	**Major Sources in the Home**	**Possible Health Impacts**
Asbestos – A natural mineral **fibre used in various building materials. All homes more than about 20 years old are likely to have some asbestos.**	*Damaged or deteriorating ceiling, wall, and pipe insulation. *Vinyl-asbestos floor material *Fireproof gaskets in heat shields, wood stoves, and furnaces *Acoustical materials *Thermal insulation *Exterior siding	*No immediate symptoms *Chest, abdominal and lung cancers and asbestosis *Asbestos can cause lung cancer, especially among smokers.600 to 1,000 U.S. deaths yearly are asbestos- related-- mostly from workplace exposure
Volatile Organic Chemicals (VOCs) – Airborne chemicals contained in many household	*Aerosol sprays, hair sprays, perfumes, solvents, glues, cleaning agents, fabric softeners, pesticides,	*Eye, nose, throat irritation *Headaches *Loss of coordination

products	paints, moth repellents, deodorizers, and other household products *Dry-cleaned clothing *Moth balls *Tobacco smoke	*Confusion * Damage to liver, kidneys, and brain *Various types of cancer
Formaldehyde – Pungent gas released into air	*Pressed wood products(plywood, panelling, particle board) *Urea-formaldehyde foam wall insulation *Carpets, draperies, furniture fabrics *Paper products, glues, adhesives *Some personal care products *Tobacco smoke	*Allergic reactions *Eye, nose and throat irritation *Headaches *Nausea, dizziness, coughing *Cancer a possibility # *Sensitivity varies widely
Lead – Natural element once used as a component in gasoline, house paint, solder and water pipes.	*Household dust from lead paint *Lead-based paint *Water from lead or lead- soldered pipes or brass fixtures *Soil near highways/ lead industries *Hobbies such as working with stained glass and target shooting Lead-glazed ceramic ware *Some folk medicines	*Damage to brain, kidneys, and nervous system *Behavioural and learning problems *Slowed growth *Anaemia *Hearing loss *Large doses can be fatal
Carbon monoxide – An odourless, colourless gas	*Appliances or heaters that burn natural gas, oil, wood, propane or kerosene. *A major component of car exhaust	

(Source indoor Air Quality and Your Home. New York State Energy Research and Development Authority, Albany, NY. And Home Indoor Air Quality Assessment. Michael P. Vogel, Ed.D. Extension Housing Specialist, Montana State University Extension Service. And Quick IAQ Facts for the Community Educator. Joseph T. Ponessa, Ph.D., Associate Professor/Housing & Energy Specialist, Rutgers Cooperative Extension Service, New Jersey)

Table III: Indoor Plants and their pollutants removal characteristic

Name of plants	Benzene	Formal dehyde	Trichloroethylene	Xylene and Toluene	Ammonia	Toxic to dog or cat
Aloe vera	Yes	Yes	Yes	No	No	Toxic
Areca Palm (*Dypsis lutescens*)	No	Yes	No	Yes	No	Non Toxic
Bamboo Palm (*Chamaedorea seifrizii*)	Yes	Yes	Yes	Yes	No	Non Toxic
Banana (*Musa oriana*)	No	Yes	No	No	No	Non Toxic
Barberton Daisy (*Gerbera jamesonii*)	Yes	Yes	Yes	No	No	Non Toxic

Boston Fern (*Nephrolepis exaltata* 'Bostoniensis')	No	Yes	No	Yes	No	Non Toxic
Chinese evergreen (*Aglaonema modestum*)	Yes	Yes	No	No	No	Toxic
Carnstalk Deracaena (*Dracaena fragrans*' Massangeana')	Yes	Yes	No	No	No	Toxic
Dendrobion orchids *Dendrobium* spp.	No	No	No	Yes	No	Non Toxic
Variegated snake plant mother-in-law's tongue (*Sansevieria trifasciata* 'Laurentii')	Yes	Yes	Yes	Yes	No	Toxic
Heartleaf philodendron(*Philo de ndron cordatum*)	No	Yes	No	No	No	Toxic
Selloum philodendron (*Philodendron bipinnatifidum*)	No	Yes	No	No	No	Toxic
Elephant ear philodendron (*Philodendron domesticum*)	No	Yes	No	No	No	Toxic
Janet craig (*Dracaena deremensis "Janet Craig"*)	Yes	Yes	Yes	No	Toxic	Toxic
Red edged dracaena (*Dracaena marginata*)	Yes	Yes	Yes	Yes	No	Toxic
Weeping fig (*Ficus benjamina*)	No	Yes	No	Yes	No	Toxic
Rubber plant (*Ficus elastica*)	No	Yes	No	No	No	Toxic
Domb canes (*Dieffenbachia* spp.)	No	No	No	Yes	No	Toxic
King of hearts (*Homalomena wallisii*)	No	No	No	Yes	No	Toxic

Moth Orchid (*Phalaenopsis* spp.)	No	No	No	Yes	No	Non-toxic
Dwarf date palm (*Phoenix roebelenii*)	No	Yes	No	Yes	No	Non-toxic
Kimbertlay queen fern (*Nephrolepis obliterata*)	No	Yes	No	Yes	No	Non-toxic
English ivy (*Hedera helix*)	Yes	Yes	Yes	Yes	No	Toxic
Spider Plant (*Chlorophytum comosum*)	No	Yes	No	Yes	No	Non-toxic
Devil's ivy Pothos plant (*Epipremnum aureum*)	Yes	Yes	No	Yes	No	Toxic
Peace Lily (*Spathiphyllum*' Mauna Loa')	Yes	Yes	Yes	Yes	Yes	Toxic
Flamingo Lily (*Anthurium andraeanum*)	No	Yes	No	Yes	Yes	Toxic
Florists Chrysanthemum (*Chrysanthemum morifolium*)	Yes	Yes	Yes	Yes	Yes	Toxic
Warneckei (*Dracaena deremensis "Warnecke"*)	Yes	Yes	Yes	No	No	Toxic