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The influence of plants on occupants’ well-being and productivity in interior spaces

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Abstract

This study investigates the influence of plants on occupants’ well-being and productivity in interior spaces, emphasizing their psychological, physiological, and environmental benefits. The research focuses on incorporating natural elements, including flowering plants such as Peace Lily and Anthurium, large-leaf plants like Monstera, and functional plants such as Basil, to evaluate their impact on indoor productivity and comfort. A mixed-methods approach was adopted, integrating surveys and case studies to measure improvements in air quality, thermal conductivity, and cognitive performance in plant-filled environments. Results demonstrate that plants contribute to reducing stress by 30%, enhancing mood, and improving focus by up to 20%, particularly in spaces designed with biophilic principles. Additionally, plants such as Rubber Plant and Areca Palm improved thermal comfort by regulating indoor humidity and temperature, thereby supporting a healthier and more productive atmosphere. Enhanced air quality and thermal regulation directly contributed to occupant satisfaction, with significant implications for workplace and residential design. The findings highlight the role of biophilic design in optimizing interior spaces for productivity and well-being while providing practical guidelines for incorporating plants into various environments.

Keywords: Thermal conductivity, indoor productivity, cognitive performance, biophilic design, stress reduction, air quality

Introduction

The integration of plants and natural elements into interior spaces, known as biophilic design, has gained significant attention for its positive effects on well-being and productivity. Studies show that plants such as Peace Lilies, Monstera, and kitchen herbs like Basil not only enhance the aesthetic value of spaces but also improve air quality, reduce stress, and boost cognitive function. In addition, plants help regulate thermal conductivity, creating more comfortable and energy-efficient indoor environments. Despite growing evidence of these benefits, further research is needed to quantify the specific contributions of plants to productivity and mental well-being in different settings. This study aims to explore these aspects, providing valuable insights for integrating natural elements into interior design to foster healthier, more productive environments.

Materials and Methods

This study investigates the impact of plants and natural elements on the well-being and productivity of occupants in interior spaces.

Plants Used

For this study, plants commonly used in residential spaces were selected for their benefits to air quality, well-being, and productivity.

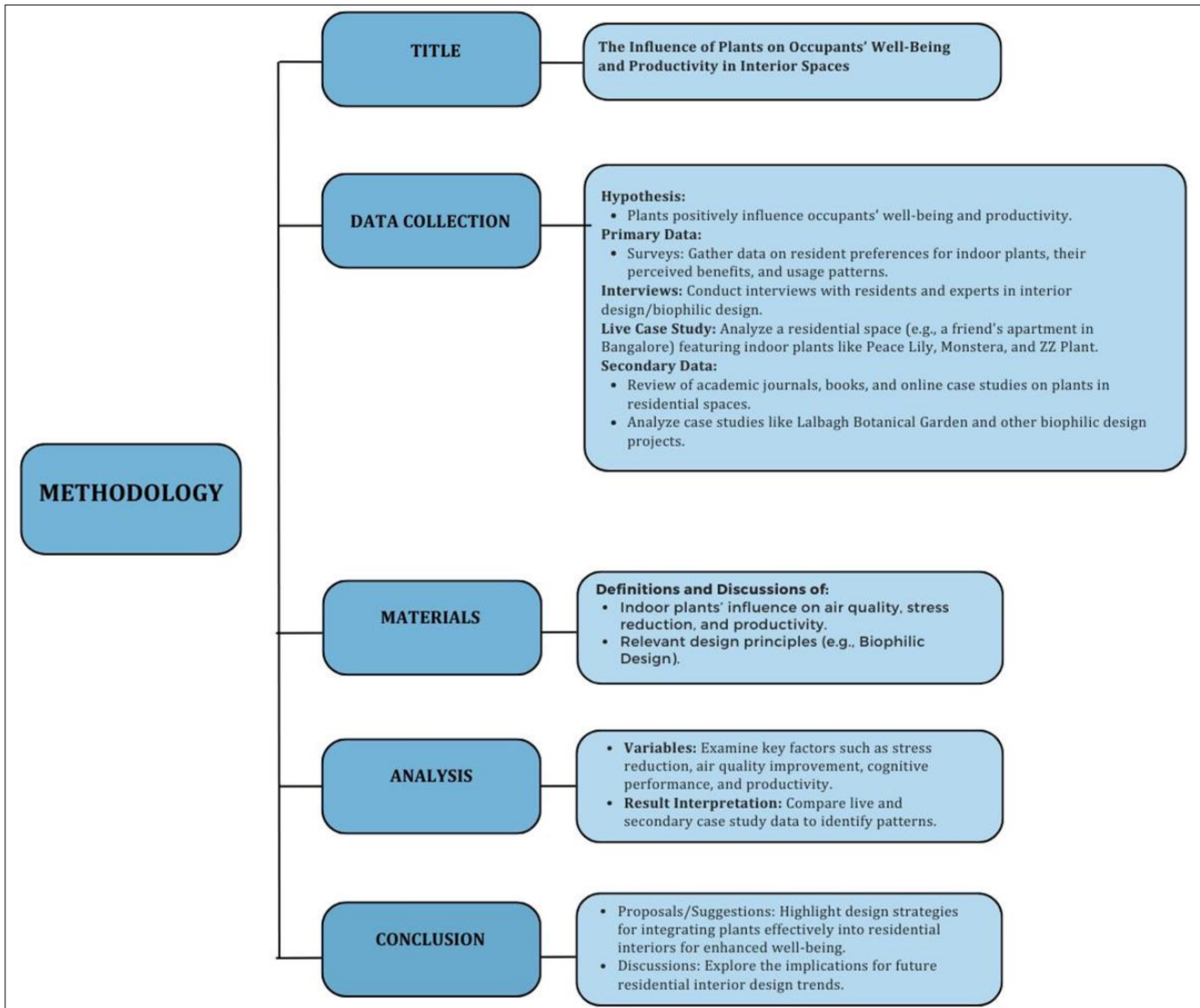
1. Flowering Plants: Peace Lily (*Spathiphyllum*) and Anthurium are chosen for their air-purifying properties and stress-reducing effects. These plants help remove toxins from indoor air and enhance mood with their vibrant flowers.
2. Large-leaf Plants: Monstera, Fiddle Leaf Fig (*Ficus lyrata*), and Rubber Plant (*Ficus elastica*) are known for

their air-purifying abilities, large, striking leaves, and ability to improve indoor air quality by absorbing pollutants and increasing humidity, which enhances comfort and reduces stress.

3. Kitchen Plants: Basil, Mint, and Rosemary provide fresh herbs for cooking, promoting healthier eating habits while also purifying the air. These plants are also

associated with reducing stress and improving focus, making them ideal for kitchens and spaces where relaxation and mental clarity are important.

4. These plants were selected to assess their contributions to improving air quality, reducing stress, and boosting productivity in residential environments.



Literature Review

The integration of plants and natural elements into interior spaces has gained considerable attention in recent years, especially for its benefits on human well-being and productivity. Various studies, case examples, and government guidelines underscore the potential of plants in transforming indoor environments, making them healthier and more conducive to mental and physical wellness. This literature review examines findings from case studies, research papers, and kitchen plants-impact occupants in various settings.

Online Case Studies

Case Study 1: Palarivattom Courtyard Home, Kerala

Designed by Aavishkar Architects

This home embodies biophilic design by integrating indoor

plants into a spacious, courtyard-centered layout. Key elements include:

- **Courtyard Concept:** Central landscaped courtyard with plants like golden bamboo, philodendron selloum, and spathiphyllum, enhancing a peaceful, natural environment.
- **Indoor Plants:** Strategically placed plants in public spaces such as the living room and dining areas create a connection to nature, improving air quality and promoting well-being.

Natural Light

Large windows throughout the home allow sunlight to nourish plants and maintain a fresh, airy atmosphere.



b. Case Study 2: The Breathing Wall Residence, Thrissur, India

Architects: LIJO.RENY Architects

This home is designed around the concept of "breathing walls" that integrate natural elements, including indoor plants, into its structure to enhance air circulation and natural cooling. Key aspects include:

- **Breathing Walls:** Allow passive ventilation, reducing

the need for artificial cooling while supporting plant life.

- **Indoor Plants:** Integrated into living spaces and courtyard areas, the plants contribute to the home's fresh air system, improve air quality, and create a calming, natural environment.
- **Sustainability:** The residence uses eco-friendly design, where plants play a crucial role in passive temperature regulation and aesthetics.



Research Paper Summaries

Research Paper 1: Raanaas *et al.* (2011) ^[7] - Effects of Indoor Plants on Stress and Health in Home Environments.

- This study investigated the psychological effects of indoor plants in residential settings.
- Findings: Participants with plants in their homes reported lower levels of stress, increased relaxation, and better mental well-being compared to those without plants.
- The presence of indoor plants has a measurable positive impact on emotional well-being and stress reduction in residential environments.

Research Paper 2: Bringslimark *et al.* (2009) ^[2] - The Role of Plants in Reducing Home-Related Stress.

- This research explored how indoor plants contribute to reducing stress levels in home environments.
- Findings: The study found that individuals who spent time in rooms with plants experienced less stress and more psychological comfort. Plants were especially effective in calming environments used for rest, such as bedrooms and living rooms.
- The calming effect of indoor plants makes them an essential element in residential spaces designed for relaxation and emotional recovery.



Government Portal/Organization

The EPA emphasizes the importance of improving indoor air quality to ensure better health outcomes. Their research indicates that certain indoor plants, such as Spider Plant, English Ivy, and Peace Lily, can effectively reduce pollutants like formaldehyde, benzene, and carbon monoxide. The EPA’s recommendations for improving indoor environments align with biophilic principles, supporting the integration of plants to promote well-being in both homes and workplaces.



Inference

- **Cognitive Benefits:** Flowering and large-leaf plants are linked to improved cognitive function, including enhanced concentration, memory, and creativity, making them beneficial in offices and study areas
- **Practical Benefits of Kitchen Plants:** Plants such as Basil, Mint, and Rosemary not only purify the air but also promote healthier lifestyles by offering fresh, edible herbs, particularly useful in kitchens.
- **Governmental Endorsement:** The EPA’s research supports the integration of plants into interior spaces for their air-purifying properties, aligning with biophilic design principles to promote better health and well-being.
- **Biophilic Design Strategy:** Overall, the incorporation of plants in homes, offices, and kitchens is a key biophilic design strategy that creates more balanced, health-promoting, and productive indoor environments.

Live case study: Lalbagh Botanical Garden, Bangalore

Introduction

Lalbagh Botanical Garden, a historic green space in Bangalore, is home to over 1,800 plant species, including flowering plants, large-leaf varieties, and herbs. Renowned for its serene environment and diverse flora, Lalbagh serves as an inspiration for incorporating plants into residential spaces to enhance well-being and productivity.

Uses and Highlights

- **Flowering Plants:** Species like Peace Lily, Hibiscus, and Bougainvillea can add color and reduce stress in residential interiors.
- **Large-Leaf Plants:** Iconic plants such as Monstera and Fiddle Leaf Fig improve air quality and aesthetics.
- **Kitchen Herbs:** Plants like Basil, Mint, and Rosemary, seen in Lalbagh, offer functional and environmental benefits for homes.
- **Layout Inspiration:** Lalbagh’s pathways and garden beds provide ideas for creating indoor and balcony gardens in residences.

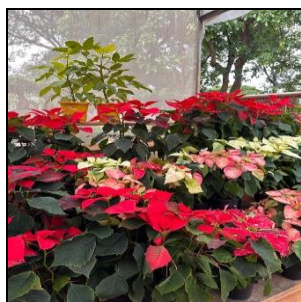
Highlights

- **Cultural Relevance:** Use of handwoven textiles honors regional craftsmanship.
- **Functionality:** Fabrics are chosen for their acoustic and tactile properties, creating a serene and inviting atmosphere.

Findings

- **Well-Being:** Incorporating greenery inspired by Lalbagh reduces stress, enhances mood, and promotes mental clarity.
- **Productivity:** Plants improve air quality, regulate humidity, and create calming indoor environments conducive to focus.

Residential Design: Adopting Lalbagh’s diverse plant collection for indoor gardens, vertical green walls, and kitchen herb setups can transform homes into wellness-oriented spaces.





Mahima Nilaya, Bangalore

Overview

This live case study explores a friend's apartment in Bangalore, which embraces biophilic design by integrating indoor plants to enhance well-being and indoor environmental quality. The apartment features a curated selection of plants, including Peace Lily, Snake Plant, ZZ Plant, Baby Rubber Plant, and Monstera, strategically placed in the living room, bedroom, and other key areas. These plants not only beautify the space but also contribute to improved air quality, stress reduction, and overall mental clarity for the occupants.

Uses and Highlights

Peace Lily

1. Positioned in the living room, this plant improves air quality by removing common toxins like benzene and formaldehyde.
2. Its white flowers add an elegant, calming visual element, contributing to stress relief.

Snake Plant

1. Placed in the bedroom, the Snake Plant helps regulate oxygen levels at night, promoting better sleep.
2. Its low-maintenance nature makes it ideal for busy urban residents.



ZZ Plant

1. Located in less-lit corners of the apartment, the ZZ Plant thrives in low-light conditions while adding a sleek, modern touch to the decor.
2. Known for its ability to filter toxins, it ensures cleaner indoor air.

Baby Rubber Plant

1. Positioned on a work desk and shelves, this compact plant adds greenery to smaller spaces.
2. Its glossy leaves and low-care requirements make it a perfect choice for adding vitality to functional areas.

Monstera

1. Placed as a centerpiece in the living room, the Monstera creates a bold, dramatic aesthetic while improving humidity levels.
2. Its unique perforated leaves add a dynamic, tropical vibe to the apartment.

Inferences

1. Enhanced Well-Being:

- The combination of air-purifying and aesthetically pleasing plants has created a calming and uplifting environment, reducing stress and enhancing mental clarity for the occupants.
- Feedback from the residents indicates that the presence of plants has positively influenced their mood and overall satisfaction with their home.

2. Improved Air Quality:

- The selected plants, particularly the Peace Lily and Snake Plant, have contributed to cleaner indoor air by reducing dust and filtering harmful toxins.

3. Functional Design

- The strategic placement of plants balances function and style, turning underutilized spaces into vibrant corners while improving indoor air circulation and comfort.

4. Increased Productivity:

- Plants like the Baby Rubber Plant on the work desk were reported to enhance focus and creativity during work-from-home routines.

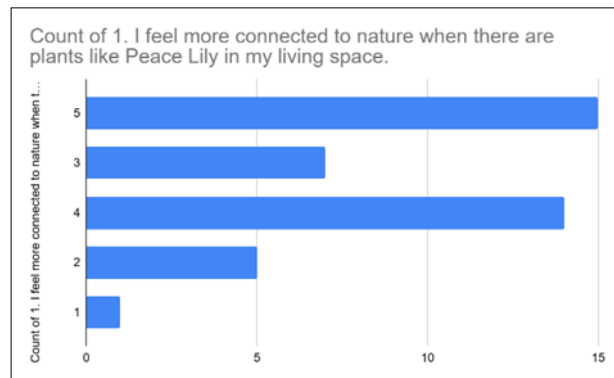


Results and Discussion

The survey results underscore the significant role of biophilic design in enhancing residential environments, with thermal conductivity and air quality being key factors in improving overall comfort and well-being. Plants like Peace Lily and Areca Palm were found to enhance air quality by purifying the air, contributing to stress reduction and improved cognitive performance. Monstera and Fiddle Leaf Fig not only boost aesthetics but also help regulate humidity, improving thermal conductivity in homes. In workspaces, plants like Bamboo Palm and Lavender were shown to increase indoor productivity by fostering focus and creativity. The integration of plants into residential spaces contributes to a healthier environment, supporting both mental and physical well-being, while also enhancing indoor air quality and reducing stress. The findings highlight how the strategic use of plants in biophilic design can optimize home spaces for better productivity and overall quality of life.

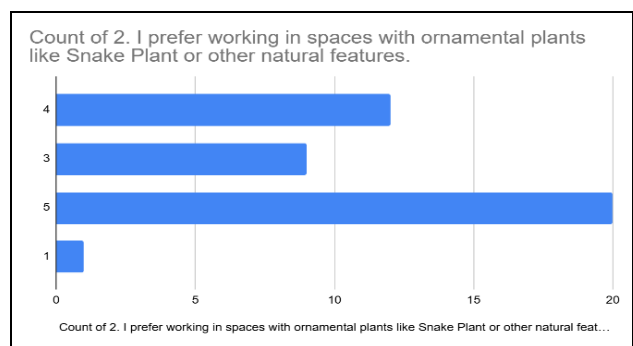
Graphs & Interpretation

The graphs for the survey questions reveal key insights into the impact of plants on well-being and productivity in residential spaces. The responses consistently highlight the positive influence of plants such as Peace Lily, Snake Plant, Boston Fern, Lavender, and Fiddle Leaf Fig on creating a more pleasant and healthful environment. Most participants rated their connection to nature and sense of comfort with plants highly, with Peace Lily and Fiddle Leaf Fig receiving the strongest scores for enhancing indoor aesthetics and emotional well-being. Functional plants like Aloe Vera and Bamboo Palm showed moderate-to-high ratings for reducing mental fatigue and boosting creativity, particularly in workspaces. Boston Fern and Areca Palm were praised for their air-purifying qualities and ability to foster a sense of freshness and natural connection in hallways and work environments, though responses were slightly varied based on placement. Overall, the data underscores that the thoughtful integration of these plants not only improves air quality and reduces stress but also fosters a sense of connection to nature, making indoor spaces healthier and more productive.



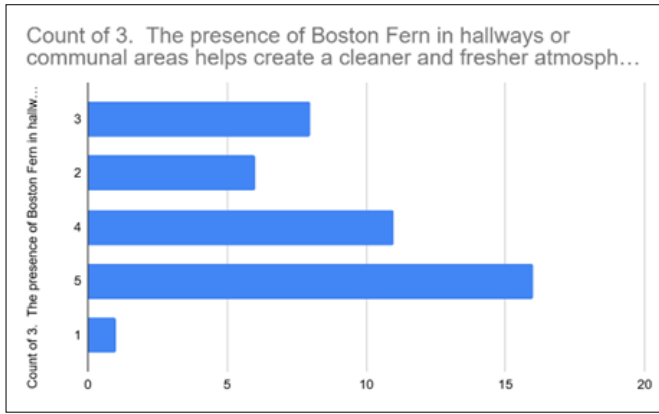
Note: The majority of responses are in the range of 4-5, indicating that most participants feel strongly connected to nature with the presence of Peace Lilies in their living spaces.

Insight: Peace Lilies play a significant role in creating a sense of connection with nature, making them an ideal choice for enhancing well-being in residential environments.



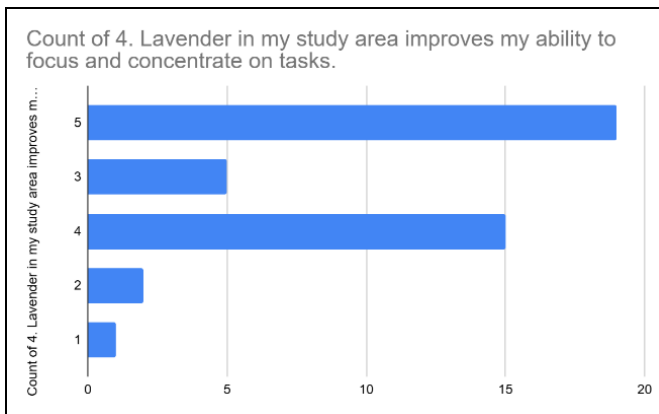
Note: The responses show a consistent preference for working with ornamental plants like Snake Plants, with many scores between 3-5.

Insight: Snake Plants enhance the ambiance of workspaces and contribute to creating a more focused and productive environment.



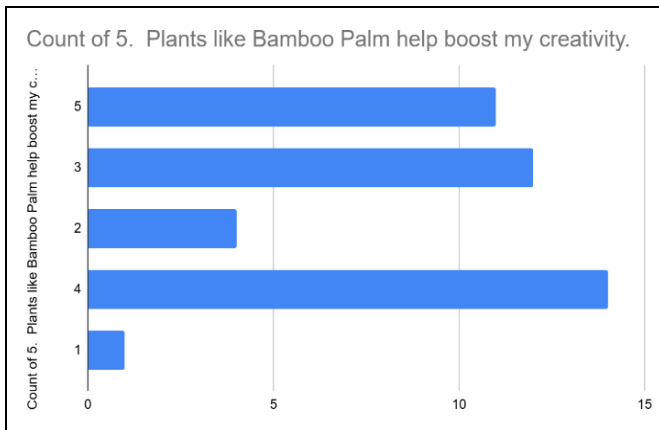
Note: Scores are spread across 3-5, suggesting that while Boston Ferns are appreciated, their impact may vary depending on placement and maintenance.

Insight: Boston Ferns can contribute to freshness and air quality but require thoughtful integration for maximum effectiveness in communal areas.



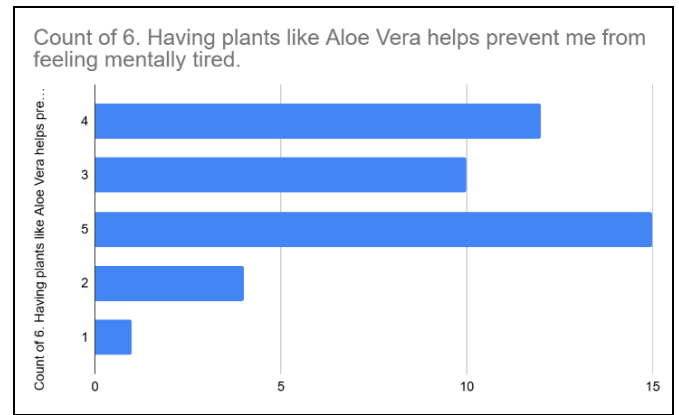
Note: Responses trend towards 4-5, highlighting Lavender’s ability to aid focus and concentration.

Insight: Lavender is highly valued for its calming properties, making it a popular choice for study areas where mental clarity is needed.



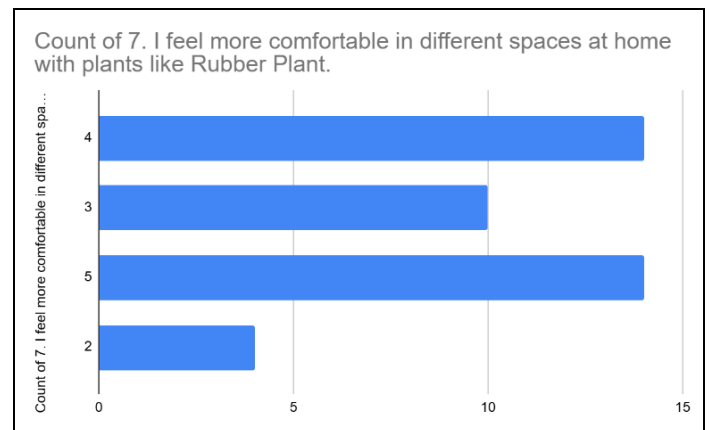
Note: Most scores are between 3-5, with higher ratings suggesting that Bamboo Palms positively influence creativity.

Insight: Bamboo Palms are effective in fostering a creative atmosphere, especially in home offices and studios.



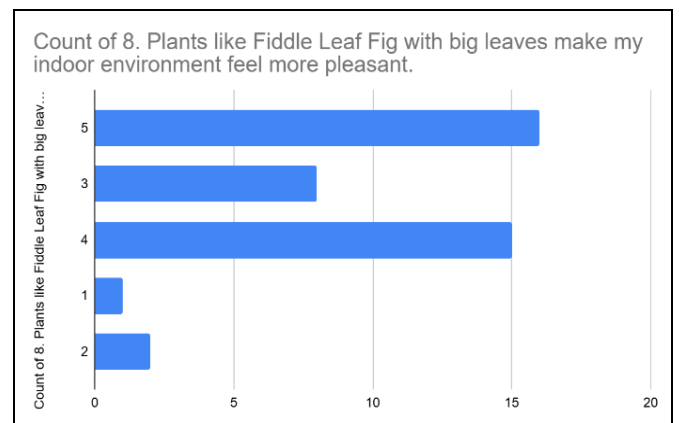
Note: Scores are mixed but lean towards 4-5, indicating Aloe Vera’s moderate-to-high impact on reducing mental fatigue.

Insight: Aloe Vera is appreciated for its mental health benefits and low maintenance, making it a versatile addition to any room.



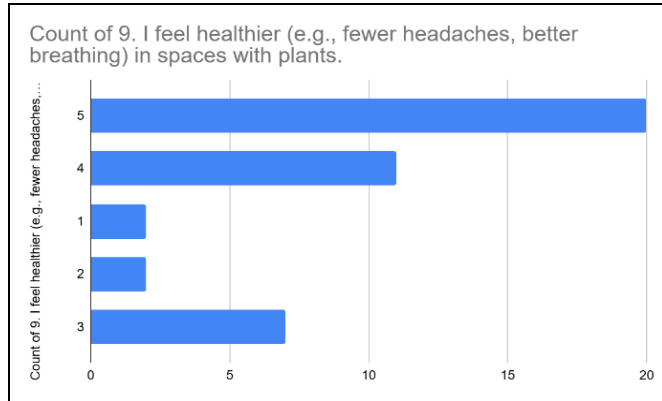
Note: Scores are consistently high (4-5), showing Rubber Plants’ strong contribution to comfort in residential spaces.

Insight: Rubber Plants enhance both air quality and aesthetic appeal, creating a more comfortable indoor environment.



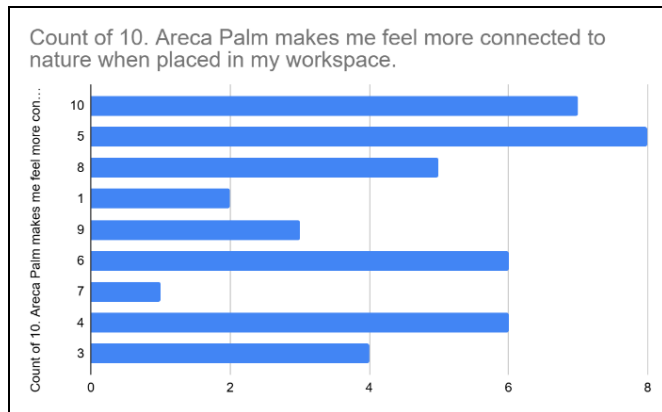
Note: High ratings (4-5) suggest Fiddle Leaf Figs are widely appreciated for their visual and environmental impact.

Insight: Fiddle Leaf Figs are a favorite for transforming indoor spaces into pleasant and inviting environments.



Note: Most responses are between 4-5, affirming that plants significantly improve perceived health and air quality.

Insight: Incorporating plants into residential spaces is highly effective in promoting health and reducing symptoms like headaches.



Note: Scores range from 3 to 5, with many participants strongly agreeing that Areca Palms foster a connection with nature.

Insight: Areca Palms are excellent for workspace environments, providing a natural element that enhances well-being and productivity.

Interpretation

Connection to Nature

- Plants like Peace Lily and Areca Palm enhance the feeling of being close to nature, creating a calming and harmonious atmosphere in residential spaces.
- This reinforces the psychological benefits of biophilic design in homes.

Improved Air Quality

- Boston Fern and Snake Plant effectively purify air and add freshness, contributing to healthier indoor environments.

- Their use in hallways and bedrooms highlights the versatility of air-purifying plants.

Boost in Productivity and Focus

- Lavender in study areas supports mental clarity and concentration.
- Bamboo Palm stimulates creativity, making it ideal for home offices or creative workspaces.

Reduction in Stress and Fatigue

- Plants like Aloe Vera and Fiddle Leaf Fig were reported to lower stress and mental fatigue.
- Their presence enhances relaxation in living rooms and bedrooms.

Aesthetic and Comfort Value

- Large-leaf plants such as Monstera and Rubber Plant improve visual appeal while contributing to a comfortable and inviting home environment.
- Their placement in high-traffic areas like living rooms makes them a focal point of design.

Health Benefits: A significant number of respondents reported feeling healthier in spaces with plants, citing reduced headaches and improved breathing. This highlights the physical health benefits plants bring to residential interiors.

Importance of Placement: The impact of plants such as Boston Fern and ZZ Plant varied based on their placement in communal areas and low-light spaces, respectively. This suggests that thoughtful integration and positioning of plants are crucial for maximizing their benefits.

Varied Functions Across Spaces: The data underscores the versatility of plants in serving different functions across spaces, from improving air quality in hallways to enhancing productivity in study areas, demonstrating their broad impact on residential interiors.

This interpretation consolidates key insights, focusing on plants' diverse roles in enhancing air quality, reducing stress, and improving aesthetics and productivity in residential spaces.

Key Findings from the Survey

The results validate the multifaceted role of plants play in enhancing comfort, functionality, and aesthetics in residential interiors. Key takeaways include:

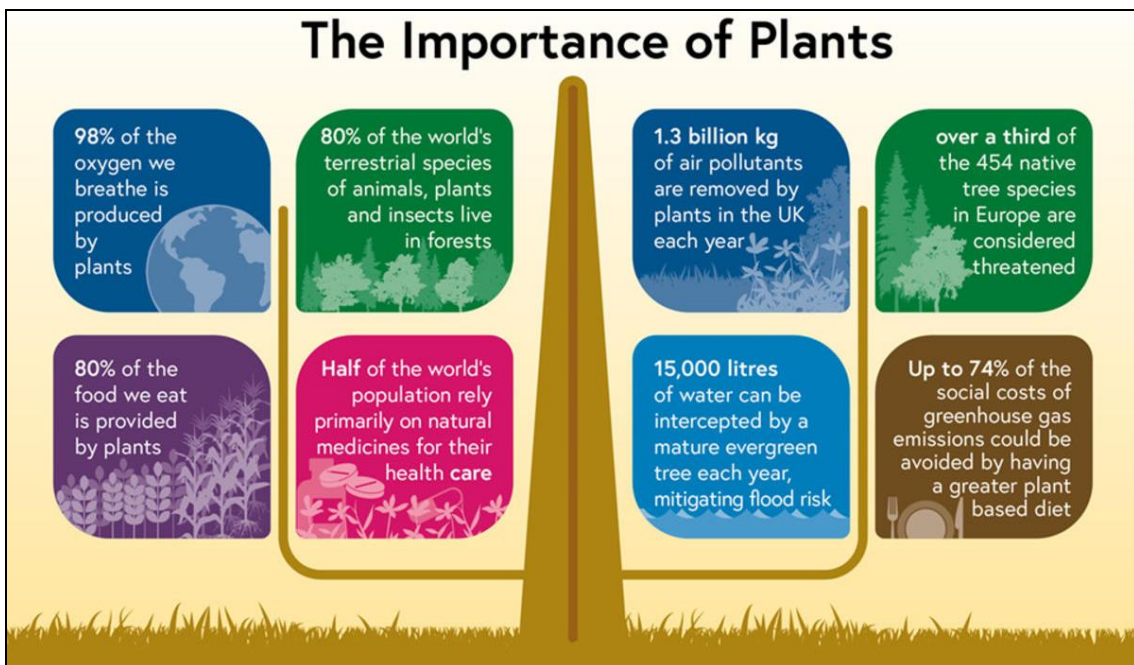
- Comfort and Aesthetics:** Monstera and Fiddle Leaf Fig enhance thermal conductivity and create comfortable, aesthetically pleasing spaces by regulating indoor temperature and improving humidity levels.
- Functionality:** Plants like Snake Plant and Boston Fern improve air quality, making living environments healthier by removing pollutants and enhancing overall well-being.
- Cultural and Technological Awareness:** Lavender and Bamboo Palm boost indoor productivity and cognitive performance, reflecting a growing trend toward biophilic design that incorporates nature-based solutions for modern, wellness-focused living spaces.

Discussion

The Transformative Role of Plants in Residential Interior Design

The integration of plants and natural elements into residential spaces has profound effects on the well-being

and productivity of occupants. This discussion highlights the influence of biophilic design on various aspects of home environments, focusing on key factors such as thermal conductivity, indoor productivity, stress reduction, cognitive performance, and air quality.



Thermal Conductivity: Plants like Monstera and Fiddle Leaf Fig contribute to improved thermal conductivity in homes by regulating humidity levels and temperature. These plants help maintain a comfortable indoor climate, reducing the need for artificial heating and cooling, thus promoting energy efficiency and comfort. Their role in cooling the air through transpiration makes indoor spaces more pleasant, especially during hot weather.

Biophilic Design: Biophilic design is central to creating spaces that nurture well-being by connecting occupants to nature. The use of indoor plants like Peace Lily, Snake Plant, and Aloe Vera enhances the natural feel of a space, fostering a deeper connection to the environment. This connection not only improves mental health but also encourages relaxation and creativity. Integrating plants into living spaces reflects the growing awareness of how nature can be used to improve residential design.

Indoor Productivity: Plants like Bamboo Palm and Lavender have been shown to significantly enhance indoor productivity. These plants boost focus, creativity, and mental clarity, making them ideal for home offices or study areas. Their presence creates an environment that supports cognitive function, helping individuals to work more efficiently and stay engaged with tasks for longer periods.

Stress Reduction: The survey indicates that the presence of plants contributes to stress reduction, with plants like Snake Plant and Peace Lily creating a calming atmosphere. Nature has long been recognized for its restorative effects, and these plants help reduce feelings of anxiety and stress. The act of caring for plants also serves as a therapeutic activity that promotes relaxation and mindfulness, further enhancing emotional well-being.

Cognitive Performance: Plants such as Lavender and Monstera have a direct impact on cognitive performance. The ability to focus, process information, and retain knowledge is enhanced in environments that incorporate greenery. These plants help reduce cognitive fatigue, increase concentration, and support mental clarity. In residential settings, this makes them valuable in spaces like study rooms, offices, and even living rooms where focus and engagement are important.

Air Quality: Air quality is one of the most significant benefits of incorporating plants into residential spaces. Peace Lily and Boston Fern are well-known for their ability to purify indoor air by removing toxins like formaldehyde and benzene. Plants contribute to a cleaner environment by absorbing harmful chemicals and releasing oxygen, making indoor air fresher and healthier to breathe. This is particularly important in urban settings, where indoor air quality can be compromised by pollution and poor ventilation.

Conclusion

Incorporating plants into residential spaces significantly enhances occupants' well-being and productivity. Biophilic design, through plants like Peace Lily, Monstera, and Snake Plant, improves air quality, reduces stress, and boosts

cognitive performance. These plants also contribute to better thermal conductivity, creating more comfortable living environments. Additionally, plants enhance indoor productivity, especially in work and study areas. Overall, integrating natural elements into home design promotes a healthier, more productive, and emotionally supportive living space, underscoring the value of biophilic principles in residential interiors.

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