

## URBAN SUSTAINABILITY WITH COCO-PEAT: THE VERTICAL GARDEN SOLUTION

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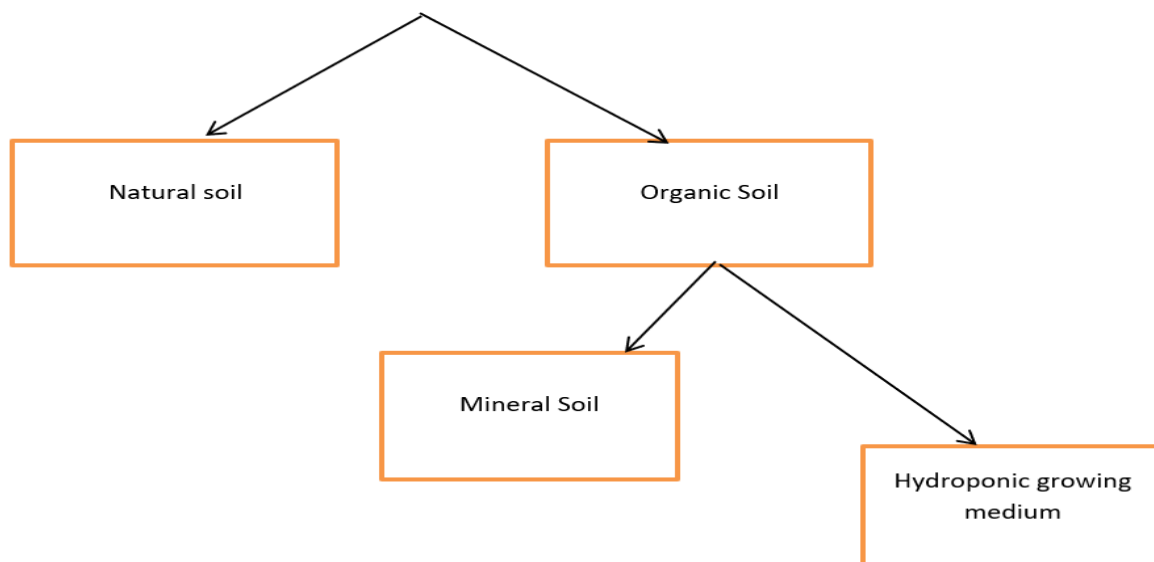
**Abstract:** The use of coco peat as a growing medium offers a promising solution for enhancing water retention in garden soil, particularly in the context of vertical gardening. Its lightweight nature and effective growth properties make it an ideal choice for vertical gardening, eliminating the necessity for fertilizers and herbicides typically associated with peat. This article aims to determine the feasibility of using coco peat composite material in urban construction of vertical plants. Experiments were undertaken in a systematic manner, consistent with the guidelines for vertical gardening, in order to determine whether coco peat can be satisfactorily used as a vegetative growth medium, soil substitute or additive, or component of a potting mix. Various flowering plants and vegetation were grown in pots containing both natural soil and coco peat, demonstrating remarkable growth performance, even in the absence of manure. Unlike conventional soil, coco peat retains water efficiently, preventing waterlogging and promoting optimal moisture levels. Having retention ranging from 7-8 times its own weight, coco peat increases aeration and drainage contributing to better root development. Additionally, though not a requirement, it is useful to combine coco peat with other soil constituents or substances as it results in a healthy organic growth medium which is helpful when growing plants in difficult environmental conditions.

**Keywords:** Cocopeat, vertical gardening, living walls, organic soil, growing mediums

### Introduction

The increasing urbanization has led to a growing need for green spaces in cities, particularly in high-rise and multi-story buildings, making vertical gardening a viable solution. Contrary to the misconception that vertical gardening requires elaborate setups, it can thrive using locally available resources, native plants, and minimal infrastructure. Urban gardening offers extensive benefits such as environmental preservation, food security, community cohesion, mental and physical well-being, educational opportunities, biodiversity conservation, and aesthetic improvements (Sheweka and Magdy, 2011). Integrating greenery into urban environments is pivotal for fostering sustainable and resilient cities.

The vitality of soil health in plant cultivation cannot be overstated, as it forms the basis for plant growth. Fertile soil provides essential nutrients for plants and hosts a diverse microbial community that aids in soil resilience against environmental stressors (Francis and Lorimer, 2011). Organic and natural soils are commonly used mediums for plant growth. Earthy soil, a prevalent choice due to its accessibility and familiarity, consists of minerals, organic matter, and finely crushed rocks. The pH levels of earthy soil vary based on location and precipitation patterns. When closely examined, earthy soil comprises a combination of five key components extracted from the ground.



**Figure 1: Types of Soil for plantation**

Primarily, natural soil is formed by using the plant's substances and often amended with manure to make sure its nutrient ranges are adjusted to nurture flora (Kalaivani and Jawaharlal, 2019). On the idea of natural depend content and composition; there are two sorts of organic soil. Organic soil is particularly composed of plant materials and is often supplemented with manure to adjust its nutrient degrees for best plant boom. Mineral soil and organic soil are two categories of organic soil distinguished via the content material and composition of organic count number. Maximum of the sector's cultivated land consists of mineral soils, which can contain everywhere from a hint to 30 percentage naturals be counted.

Organic soils, rich in organic matter due to climatic conditions, are not crucial for crop growth despite having over 30% organic content. The fiber content in organic soils is the key factor influencing bulk density, water retention, hydraulic conductivity, and drainable porosity. Gardens with herbs, flowers, or vegetables benefit from increased airflow in the soil due to the thicker organic materials, enhancing oxygen

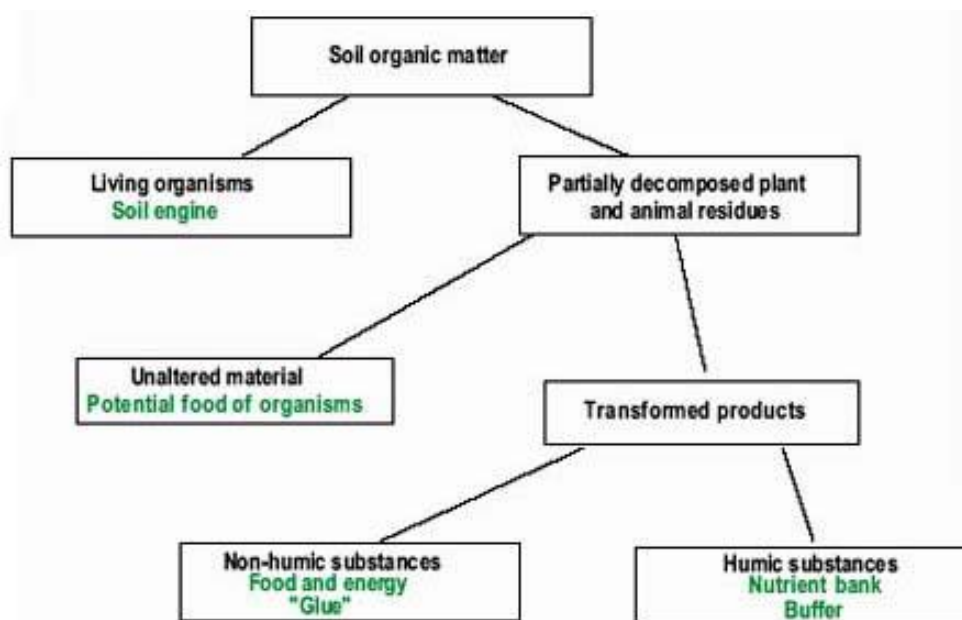
supply to plant roots. Soil organic matter comprises materials from living organisms that decompose in the soil, ranging from fresh plant and animal tissues to well-decomposed humus over time (Ghehsareh *et al.*, 2011).

With a specific set of soil features and the yearly input of plant and animal residues, soil organic matter can be diversified into different fractions. Many soil physical characteristics such as texture, pH, temperature, moisture and aeration, clay mineral content and biological activity of the soil environment are important factors that control the processes of organic matter death and the processes of accumulation of said matter within the limits of a certain ecosystem (Lin *et al.*, 2015). The presence of soil organic matter further influences soil properties, introducing complexity to the system.

Residues also contain soil organic matter that provides them a "residual" life in which most of their constituents are protected against rain degradation, wind removal and sunlight break-down. Nonetheless,

the removal or burning of this plant can be harmful to values in other respects it leads into a decrease within the atmospheric total amount and deprives potentially soil organisms with their main energy source. The

importance of organic matter in agriculture lies because it serves as a "cycling nutrient pool" and contributes to the improvement on soil texture, integrity, erosion control by filtering etc.



**Figure 2: Chemical Characteristics of Organic Soil**

Humus is a stable component of soils formed by the decomposition of plant residues and serves as an essential nutrient reservoir for plants, helping to support their growth and development. It has a major part to play as soil structure maintenance and sustenance of good health in soil with reduced erosion. As dead bodies of animals and plants decay on the earth, or when other organic material breaks down through chemical reactions in another location (such as within an animal's gut), nutrients are supplied to these ecosystems: naturally occurring water-soluble compounds (ions) that can be taken up by some groups

of organisms mainly for nutrition; oxygen also used ceremonially during respiration.

A balanced supply of food crop residues and manures has to be maintained with consumption by microorganisms, plant uptake and possible losses through leaching and erosion for a healthy nutrient cycle (Noguera *et al.*, 1998).

The dark-colored, lightweight organic soils are known for their exceptional water-holding capacities, capable of holding 200 - 400% of their dry weight in water. These soils, often referred to as peat deposits, contain over 60% organic matter and are

characterized by deep organic surface layers. They possess low bulk density, high water retention, and low load-bearing strength. Organic soils are typically acidic and exhibit unique properties that make them suitable for specific land uses, such as low-quality grazing or fuel sources.

Growing media are however indispensable for plant growth that should contain materials well-suited to grow plants in containers. The media are commercially prepared by the growing media industry, or may be made locally on farms. These are made of various substances-peat, composted organic waste, bark wood fiber coir pcerlite vermiculite etc. The term “substrate” is also used in connection to a growing medium, so the definition for it remains fairly wide-ranged. Most of these mixes are formulated using the volume percentage weight of each component, which forms an integral growth supplement for plants and may be distinguished by their appearance to eye.

### **Coco soil, Cocopeat or Khopra**

Various growth-promoting materials are readily available in the market for enhancing the growth and propagation of flowers in landscaping. Khopra, also known as Coco peat or coco coir, is a commonly used boom substrate derived from the coconut industry (Félix *et al.*, 2018). This versatile and sustainable growing medium offers excellent versatility, making it suitable for diverse purposes and catering to the needs of domestic gardening enthusiasts. Additionally, regionally sourced organic soil, also referred to as Khopra, is gaining popularity as a nutrient-rich medium for enhancing soil quality. Composed of coconut husk fibers, Grifola frondose of coconut, coconut skin or husk, leaf compost, rice ash, and natural soil, coco peat offers a lightweight,

spongy, and non-fibrous growing material suitable for landscaping purposes (Treder and Nowak, 2002).

Coco Peat at local nurseries is available in bags for PKR 800 or you can purchase it at 150 by Kgs. Coco peat, commonly known as "khopra" at the local level is used very effectively for plant health and growth suggesting its benefits highly on hydroponic systems in addition to seed germination. It is highly favored by home gardeners for its ability to support strong root development. When growing plants in containers, using a growing medium like coco-peat alongside soil can help prevent plant hazards and enhance growth by reducing the risk of fungal infections and other diseases.

Organic growing mediums, like coco-peat, are free from chemicals or pesticides, making them a natural and environmentally friendly choice for plant cultivation. These organic mediums are typically composed of carbon-based materials and are labeled as organic as long as they contain only natural components. While there is no USDA regulation on how to label organic soils, these mediums are widely available at local vendors and are cost-effective options for gardening enthusiasts (Radha *et al.*, 2018).

The sources provided highlight the benefits of using coco-peat as a sustainable and natural growing medium for plants, especially in urban areas and vertical gardening. Coco-peat, a natural fiber particle made from coconut husks, is considered an excellent alternative to artificial pesticides and chemicals, promoting plant growth without the need for additional nutrients or fertilizers. It offers advantages such as efficient water retention, lightweight nature, nutrient retention, pH neutrality, improved aeration, and sustainability, making it ideal for limited spaces and container gardening.

Studies emphasize the importance of organic soils and growing mediums like coco-peat over artificial alternatives for plant growth. Organic soils provide essential nutrients, a light texture, and adequate water and air retention, leading to better growth rates for seedlings. Home gardeners worldwide prefer organic soils due to their effectiveness in promoting plant health without the use of harmful chemicals. Research specifically focuses on the use of coco-peat in vertical gardening to analyze its impact on plant growth in urban areas, highlighting its role as a sustainable and pesticides

### **Methodology**

The primary aim of the study is to establish living walls in a densely populated urban area by utilizing indigenous plants and materials to promote recycling and restyling. The core objective is to demonstrate that creating a living wall does not necessitate elaborate structures, exotic plants, advanced technology, or high costs. Instead, the focus is on showcasing how anyone can construct a living wall to enhance the aesthetics of solid surfaces by leveraging existing materials, local flora, and straightforward plumbing techniques.

The current experimental study, titled “Exploring Coco-Peat as a Sustainable Vertical Gardening Solution for Urban Environments”. was conducted in a multi-story building located on Sharaqpur Road in the densely populated urban area of Lahore. The study incorporated specific equipment, materials, and design components to implement the vertical gardening initiative effectively. The project followed the prescribed parameters for vertical gardening to ensure the creation of a functional and aesthetically pleasing living wall. An iron frame served as the primary structure, accommodating

recycled plastic pots for planting. Indigenous plant species were selected to promote botanical growth, emphasizing both affordability and local availability.

#### **i) Irrigation system**

The irrigation system implemented in the research project was influenced by a local term known as “Pernala”. It involved the use of a customized water irrigation system designed to suit the local conditions. This method is commonly practiced in the uppermost level of multi-story buildings at a local scale. The system utilized plastic pipes to create a drip irrigation system with nozzles that deliver water precisely to the specific areas where it is needed.

#### **Type of Plantation**

Both greenery and vegetation were selected for this study, incorporating elements of kitchen gardening and aesthetic appeal through blooming plants.

#### **ii) Cocopeat as Soil for Plantation**

Soil plays a pivotal role in plant cultivation, serving as the primary medium for growth. It needs to be lightweight, capable of facilitating water penetration, and possess protective properties against harmful microbes, making it an indispensable element in living wall systems. In the current study, coco peat, also known as Khopra, was utilized as the experimental material. This versatile substance, alongside organic soil, was employed for cultivating vegetation in containers. Coco peat serves a dual purpose in this context, acting as both a substitute for organic soil and a nutrient-rich growth medium essential for plant development. The utilization of coco peat is justified by its adaptability and effectiveness in supporting plant growth.



**Figure 3: Khopra along with Pernala inspired irrigation system**

Cocopeat, an organic substance rich in nutrients, plays a vital role in nourishing plants. Weight considerations are essential in vertical gardening due to the need for structural integrity. Despite being watered, cocopeat retains its remarkably lightweight properties, making it ideal for vertical gardening setups. In this study, cocopeat was utilized both as a growing medium and as a component in pot mixes. This dual application facilitates robust plant growth by providing essential nutrients while maintaining the desired lightweight characteristic crucial for vertical gardening structures.

#### **a) Usage of Coco-peat**

The use of Cocopeat or Coco coir is extraordinarily various. The utility of this substance as a soil enhancer, fertilizer, and eco-friendly material shows capacity for enhancing soil nice. It can be

applied as a developing medium, a modification for soil, or a component in potting mixes. This material may be used as a natural medium for developing vegetation and seedlings. Its capability to break down certainly makes it an environmentally accountable alternative for this purpose. This entity represents a sustainable alternative for soil. Based on studies effects, it can be said that Cocopeat acts as a medium that encourages plant increase, main to faster boom fees when as compared to other materials. In step with empirical studies, hydroponically cultivated flora the use of coco peat as a substrate showcase a 50% improved growth price in evaluation to those grown in soil.

#### **b) Cocopeat as Growing Medium**

Furthermore, the usage of peat as a growing medium obviates the necessity to observe fertilizers,

herbicides, and insecticides because it inherently possesses an abundant deliver of vitamins. The pH degree in Cocopeat is considered to be impartial. As a result, it is amenable for employment as a hydroponic solution. Notwithstanding no longer being applied as a hydroponic system itself, it possesses the capacity to facilitate hydroponic cultivation.

### c) Cocopeat as Mixing Medium with Soil in Pots

Inside the local context, it is not unusual to include coco-peat or khopra into the soil aggregate. The exercise of incorporating it into the soil postulates some of advantages, such as an accelerated capacity for water retention, as well as the promoting of a regulated and thriving soil surroundings, this is conducive to the successful growth of flowers and gardens.

While used as a developing medium, coco coir is a fantastic choice for vegetation that requires

unfastened and airy soil. It is also a first rate desire for plant life prone to waterlogging as coco coir can maintain a large amount of water without becoming waterlogged. As a soil change, coco coir may be delivered to enhance the drainage and aeration of clay soils. It may additionally be added to sandy soils to help retain moisture. While utilized as a component in potting mixes, coco coir can be introduced to business potting mixes to enhance drainage and aeration. It can additionally be used to create your own potting blend.

Coco coir is a green and renewable substance which can decompose certainly. It functions as a top notch aerator, selling drainage and averting root decay. Coco coir is likewise a talented moisture retainer, stopping both over hydration and dehydration. It's far lightweight and person-friendly, whilst nonetheless being value-powerful.

### ADVANTAGES OF GARDENING WITH COCO PEAT



Figure 4: Advantages of Cocopeat





**Figure 5: Executed Sustainable Vertical Gardening**

### Analysis

In urban settings, vertical gardening serves as a strategic response to various challenges, including spatial constraints, environmental deterioration, and the demand for enhanced green infrastructure. This approach yields numerous advantages, contributing to the sustainability, livability, and resilience of cities. Cocopeat emerges as a favored choice for vertical gardening in urban environments due to its array of benefits. Cocopeat has many advantages such as good water retention, lightweight nature i.e., Porous particle structure, Nutrient holding capacity Nutritional additive to poor soil and pH neutral in the range of 5.0 – 6.8 ( $\pm$ ) monolithic substances, a vigor building organo-mineral component for transplantable bio

diverse root mixtures with improved aeration potential grading/improved surface-essentially. Respiratonic resiliency (Index>90%) implying guaranteed assured revaintity/resuscitance utilizing resource sustainability. Cocopeat is a viable alternative to traditional soil-based growing media, largely owing to these characteristics. It allows plants to grow well even in confined urban spaces a boon especially for areas where there are fewer patches of green.

### Conclusion

To conclude, coco peat acquitted an excellent performance as growing medium and soil amendment in this study by providing essential nutrients required for improved plant growth with good support



structure. Cocopeat emerges as an exceptional choice for plantation in urban living walls, fostering the flourishing of various flower varieties such as euphoria, dopahar-booti, and petunia. Additionally, cultivating a kitchen garden with herbs like mint, coriander, and sweet basil in soil mixed with Cocopeat proves advantageous. The use of coco-peat eliminates the need for additional pesticides or nutrients to enhance plant growth, offering a sustainable approach. Furthermore, Cocopeat's lightweight nature, even after watering, facilitates effective air circulation and moisture retention, contributing to successful cultivation. Given these factors, regular soil proves to be less suitable for this experiment, underscoring the superiority of Cocopeat in urban vertical gardening endeavors.

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### Conflict of interest statement

Compliance with Ethical Standards Conflict of interest the authors declare that they have no conflict of interest.

### Author's contribution statement

Both authors equally contributed to the research work; read, reviewed, and approved the final manuscript for publication.

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