JEE Journal of Ecological Engineering

*Journal of Ecological Engineering*, 2026, 27(3), 288–296
https://doi.org/10.12911/22998993/213649
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Received: 2025.10.11
Accepted: 2025.11.27
Published: 2026.02.01

# Alternative growing media to increase growth performance and quality of amaranthus, broccoli, watercress, alfalfa, mung bean, and pea shoot microgreens

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## ABSTRACT

This study aimed to evaluate the effect of alternative growing media cocopeat (from coconut industry waste) and rockwool on the growth as well as the quality of microgreens of vegetables such as amaranthus (*Amaranthus hybridus* L.), broccoli (*Brassica oleracea* var.Italica), watercress (*Nasturtium officinale*), alfalfa (*Medicago sativa*), and microgreen of grain crops such as mung bean (*Vigna radiata*), and pea shoot (*Pisum sativum* L). This study involved the Factorial Randomized Group Design method, which consisted of two factors. The first factor was planting media, which consisted of two levels: organic cocopeat media (C) and inorganic rockwool media (R). The second factor was the type of seed consisting of *Amaranth* sp. (Am), broccoli (B), watercress (W), alfalfa (Al), mung beans (M), and peas (P). Each treatment combination was repeated three times. Harvesting was done 10 days after planting by cutting the plant stem at the root collar. The growth and yield variables observed included plant height, total root length, fresh weight and dry weight of crown as well as fresh weight and dry weight of roots, moisture content, chlorophyll content, total dissolved solids, and vitamin C content. The results showed that the best medium for all microgreens tested was cocopeat. Microgreen mung beans had faster growth and the best crown as well as root fresh weight in microgreen watercress and alfalfa. Broccoli had better quality than other microgreens in terms of moisture content, total chlorophyll, TDS, and vitamin C. This microgreen cultivation of nutrient-rich crops is crucial for food security.

**Keywords:** cocopeat, microgreen, *Nasturtium officinale,* rockwool, *Vigna radiata.*

## INTRODUCTION

In the new global economy, microgreens have become a central issue for the agricultural industry. Microgreens are defined as immature vegetables, varying in size from species to species, but are usually between 2.5 and 8 cm in height (Bliss, 2014). The microgreens are harvested and marketed as soon as the first leaves grow, and the cotyledons remain (Treadwell et al., 2020). In addition, microgreens can be found in vegetables, herbaceous plants, grain crops, and aromatic plants (Kyriacou et al., 2020; Lenzi et al., 2019). Recently, microgreens have also received increasing attention from producers and consumers due to their soft and crunchy characteristics, specific taste, diverse colors, and high nutritional content due to the presence of several bioactive compounds, such as antioxidants, vitamins, macro and micro minerals (Galieni et al., 2020; Caracciolo et al., 2020; Turner et al., 2020). Thus, microgreens are considered functional foods (Le et al., 2020).

The survey conducted by United States Department of Agriculture (2020) provided additional evidence that microgreens have much higher concentrations of vitamins and carotenoids than mature fruits and vegetables. These concentrations are often 30–40 times higher (Choe et al., 2018). In the last decade, the research interest in microgreens has markedly increased. By country, Italy leads with 34 publications, followed by India with 13, and the United States with nine publications (Singh et al., 2024). Interestingly, mature legumes, grains, and sunflower plants are not edible, but their seeds are known to have nutritional benefits, making their microgreens edible.

Microgreens can be cultivated in any medium, including solid organic growing media like cocopeat and inorganic ones like rockwool (Di Gioia et al., 2015). Cocopeat is derived from coconut fiber, a plentiful byproduct of the coconut industry. Rockwool is an inorganic media that is naturally sterile and free of plant-disease-causing bacteria and fungus. The sterile nature of rockwool helps to prevent the growth of root infections, decreasing the need for pesticides, which are frequently a source of environmental contamination. The use of these two growing media can help to preserve environmental safety.

Many microgreen studies have been conducted, but commonly implementing vegetables such as spinach (Zhou et al., 2023), broccoli and cauliflower (Renna et al., 2020), arugula and cabbage (El-Nakhel et al., 2021), red cabbage (Johnson et al., 2021), Kale and Radish (Tomas et al., 2021), watercress (Marchioni et al., 2021), Cauliflower (Palmitessa et al., 2020), and pak choi (Xiao et al., 2019). Microgreens from grain crops, such as mung beans and peas are rarely conducted. Therefore, the objective of this study was to evaluate the effect of alternative growing media (cocopeat and rockwool) on the growth and quality of selected microgreens species, including amaranthus, broccoli, watercress, alfalfa, mung bean, and pea shoot.

## MATERIALS AND METHODS

This research was conducted in the Laboratory of Agriculture Faculty, Universitas Islam Malang, East Java, Indonesia from June to August 2025. This study used the factorial randomized group design method, which consisted of two factors. The first factor was the planting media, which consisted of two levels: organic media cocopiet (C) and inorganic media rockwool (R). The second factor was the type of seed consisting of Amaranthus (*Amaranthus hybridus* L.), Broccoli (*Brassica oleracea* var. Italica), Watercress (*Nasturtium officinale*), Alfalfa (*Medicago sativa*), and microgreen of grain crops such as mung bean (*Vigna radiata* ), and pea shoot (*Pisum sativum* L). Each treatment combination was repeated three times.

Microgreens were grown in thin wall boxes without lids with a volume of 650 ml. Before use, the box was sterilized with 75% alcohol tissue and then filled with media according to the treatment. Before planting, the seeds were soaked for 12 hours using mineral water. After that, the seeds were sown in an area that filled 75% of the planting box area. Then, the nursery box was placed on a rack and covered with a cloth for 2 × 24 hours; this is called the blackout phase, which aims to make the seeds grow simultaneously. After the seeds started to emerge, they were immediately introduced to light. Watering was done to maintain moisture so that the plants could grow well. Watering was done using a sprayer with a fogging model to keep the plants and media moist under optimal conditions during the process of germination and growth.

Harvesting was done 10 days after planting by slowly cutting the plant stem at the root collar from the planting box using scissors and grouping it according to treatment. The growth and yield variables observed included plant height measured from the cut to the highest tip of the plant; total root length was calculated using the formula $L = ¼. \pi. (H + V)$, where L = Total root length (cm), H = Intersection of the root with the horizontal axis, V = Intersection of the root with the vertical axis; fresh weight and dry weight of the crown as well as fresh weight and dry weight of the roots were carried out on 10 sample plants/boxes taken randomly. Weighing the dry weight of plants and roots was done after being in the oven for 12 hours at a temperature of 70 °C.

Evaluation of microgreen quality was carried out on the moisture content variable (Carter and Gregorich, 2008), chlorophyll content (by portable chlorophyll meter/SPAD), total dissolved solids (Sluiter, 2013), and vitamin C content (by Iodometric method) (Pisoschi et al., 2014). The observation data was obtained using analysis of variance (F test) with a real level of 5% if there is a real effect, followed by the BNJ test at the 5% level.

## RESULTS AND DISCUSSION

The variance analysis results showed an interaction effect between the type of microgreen and planting media on plant height, water content, total dissolved solid (TDS), and chlorophyll content. Other variables such as root length, plant fresh weight, root fresh weight, as well as vitamin C content have no interaction with microgreens and media treatments.

### Growth and yield variables

The results of the analysis showed that mung bean microgreens planted in cocopeat and rockwool media had the highest plant height of 9.81 cm and 8.57 cm, respectively, and were significantly different from the other treatments (Figure 1). Mung beans have the highest plant height and are not affected by the media type. This may be due to mung beans genetically having the potential for faster and higher growth compared to other species, such as alfalfa, spinach, broccoli, lettuce, and peas. Each plant species has genetic characteristics that affect its size and growth speed. This is in line with the research results (Ramya et al., 2022), which show that mung bean microgreen has the earliest first seed germination and the highest vigor index. Therefore, mung bean has the highest plant height.

There is no interaction between the type of microgreen and the media on root length. Broccoli has the shortest root length of 0.60 cm and is significantly different from other microgreens. Watercress, mung bean, and pea shoot have almost the same root length. The type of growing media affected the root length, where the highest root length was achieved in the microgreens grown on cocopeat media (1.93 cm) and significantly different from those grown on rockwool media (1.61 cm) (Figure 1).

Growing media play a crucial role in determining the growth, yield, and quality of microgreens as well as the sustainability of their production. Nurzyński, (2005) and Komosa et al., (2010) reported that although the same nutrients were applied, various media such as sand, rockwool, wood fiber, and peat had significant differences in nutrient content. Cocopeat is an organic growing medium made from the coconut fibers that are dried and crushed into fine powder. This growing medium has several advantages over rockwool. As reported by (Krishnapillai et al., 2020), cocopeat has outstanding physical and chemical characteristics such as high water holding capacity, good drainage and aeration properties, as well as high cation exchange capacity, with a pH ranging from 5.5 to 7, so air, water, and roots easily enter the growing medium and bind water (Widiwurjani et al., 2020). The absence of weeds, pathogens, and slow decomposition (Lau et al., 2019).

Similarly, with the performance of crown and root fresh weight, cocopeat media produced the best crown and root fresh weight of 22.77 g and 7.21 g, respectively, and significantly different from the microgreens grown on rockwool media (12.37 and 4.27 g). Broccoli, watercress, and alfalfa microgreens produced almost the same total plant fresh weight and root fresh weight of 18.82, 24.83, 29.83 g for total plant fresh weight and 6.44, 8.17, 7.67 g for root fresh weight, respectively (Figure 2).

The growing medium is essential for the growth and development of microgreens, and each medium will significantly impact the morphological characteristics and nutritional value of microgreens, as observed in this study. In general, the most efficient growing medium for microgreens is cocopeat, which can improve the

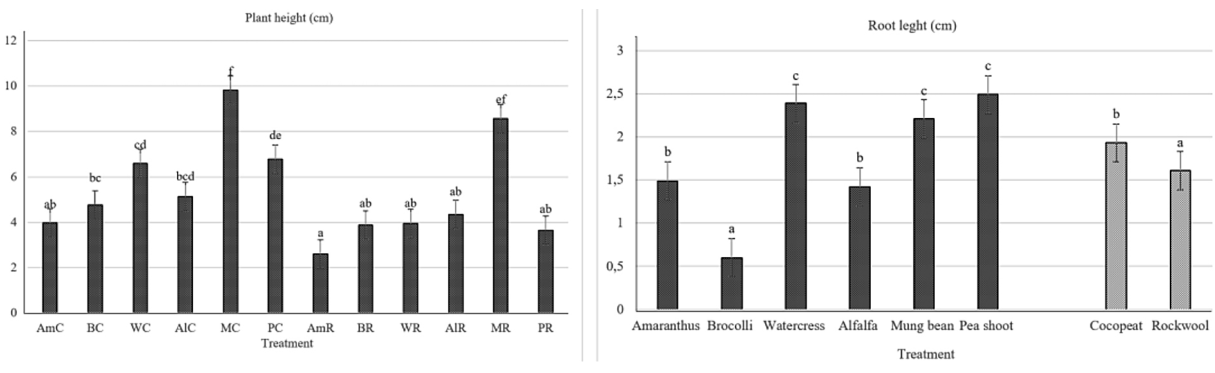


**Figure 1.** Plant height and root length of various microgreens on different media

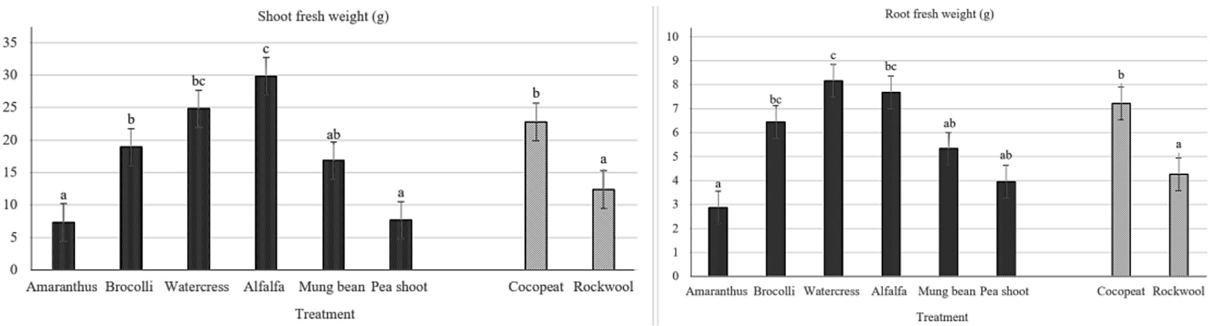


**Figure 2.** Crown fresh weight and root fresh weight of various microgreens in different media

growth and quality of microgreens (Gunjal et al., 2024). These results are similar to previous studies, which stated that cocopeat planting media responded best, followed by rockwool, sand, and husk charcoal planting media (Sulistiya, 2021).

Rockwool is a type of inorganic media with lightweight characteristics that can retain water and be cut according to shape. This media is also widely used in soil-less cultivation, including microgreens. However, rockwool media does not have the ability to hold water and cocopeat, so plants tend to lack water more quickly. In addition, the pH of rockwool media tends to be more alkaline and unstable, making it difficult to control the soil's pH level. This can cause problems for the plants requiring suitable pH (Peyvast et al., 2005). Therefore, cocopeat media is more suitable for microgreens than rockwool media. The ability of cocopeat media to bind water will affect the absorption of nutrients (Du et al., 2022; Eswaranpillai et al., 2023). In addition, economically, cocopeat media is relatively cheaper than rockwool (Awang et al., 2009).

## Quality variables

Microgreen quality was evaluated on water content, total chlorophyll, total dissolved solids, and vitamin C content. The results showed an interaction between the type of microgreen and planting media on the quality of microgreen except vitamin C content (Figures 3 and 4). This shows that the two treatments support each other. Post-harvest handling is an essential component of agricultural activities to ensure that agricultural products, especially fruits and vegetables, are in the best market possible condition (Valenzuela, 2023).

High water content characterizes the freshness of fruits and vegetables (Wang et al., 2024). Optimal moisture content in microgreens can affect the texture, flavor, and nutrient content of microgreens. A balanced moisture content helps maintain a crunchy texture and fresh flavor, as well as maintains the concentration of nutrients in the plant. In addition, fresh fruits and vegetables contain many vitamins, minerals, dietary fiber, as

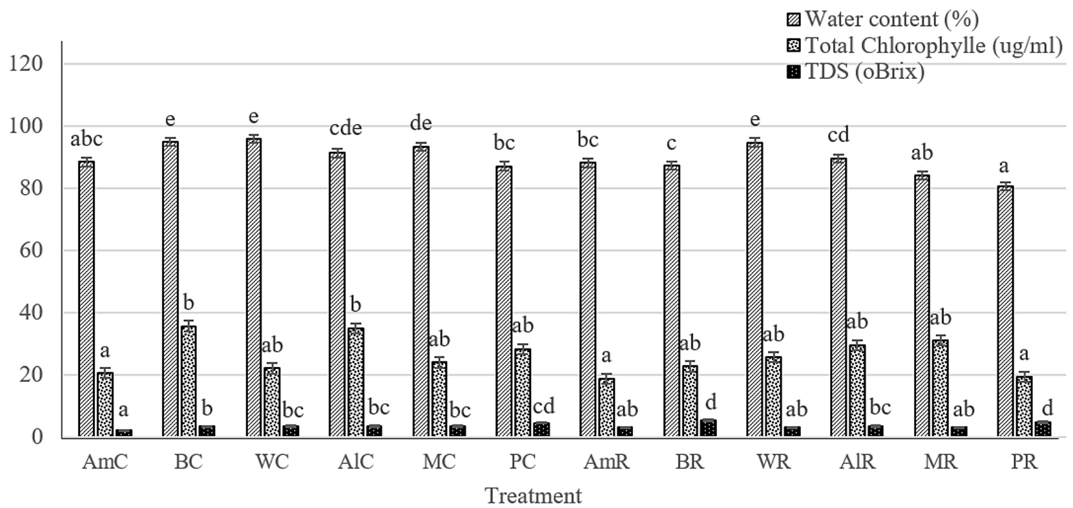


**Figure 3.** Water content, total chlorophyll, and TDS of various microgreens in different media

well as other nutrients and are a vital part of the human diet (Tao et al., 2007)).

The results of this study indicate that all types of microgreens grown in both cocopeat and rockwool media have almost the same moisture content. The moisture content of mung bean and pea microgreens grown on rockwool media was lower than the other treatment combinations. Rockwool has a high water-holding capacity but also exhibits significant drainage properties, leading to rapid moisture loss (Baek et al., 2021).

Mung beans and peas come from larger, denser seeds than other vegetable seeds. These large seeds store more energy reserves in the form of starch, allowing the plant to retain lower moisture content during germination and early growth. Pea microgreens have been shown to have lower moisture content due to their specific biochemical composition and growth conditions, which can lead to higher dry matter concentration (Pashkevich et al., 2022). The biochemical properties of microgreens, such as the presence of soluble sugars and proteins, can also affect moisture content. Pea and mung bean microgreens have high protein concentrations, which may correlate with moisture content. In addition, the absence of certain pigments, such as anthocyanins in pea microgreens, suggests different metabolic pathways that may contribute to lower water retention (Pashkevich et al., 2022).

All microgreens have almost the same total chlorophyll grown in cocopeat and rockwool media. The total chlorophyll of broccoli and alfalfa grown in cocopeat media was relatively higher than the other microgreens at 35.61 u/ml and 34.96 u/ml, respectively. Different media types, such as cocopeat, rockwool, and organic soil, have been shown to produce varying chlorophyll levels in microgreens. For example, the wheat grown in cocopeat combined with eco-enzymes produced the highest chlorophyll level of 28.3 mg/L (Maulidiyah et al., 2022; Gunjal et al., 2024; Rahayu et al., 2018). In another study, gelinggang microgreens showed the highest chlorophyll levels when grown in organic soil compared to rockwool (Rohmanna and Mulyawan, 2022). The use of agricultural waste as a growing medium also showed increased chlorophyll content, especially in sunflower and water spinach microgreens.

The pigment content in vegetables is also important for the visual appearance of the product. Color and appearance determine whether a product is accepted or rejected by consumers, and these aspects are even more relevant in products such as microgreens that are highly valued for their color (Barrett et al., 2010). Chlorophylls and carotenoids are the main photosynthetic pigments responsible for the specific coloration of microgreens (Žnidarčič et al., 2011). Chlorophyll pigments are essential for plants to photosynthesize and affect growth as well as yield. Chlorophyll synthesis requires elements such as N and P from the growing medium; thus, the growing medium can affect chlorophyll in plant leaves (Hasanuzzaman and Fujita, 2022). This is in line with the point of view of (Gunjal et al., 2024), who state that the selection of growing media significantly impacts the nutritional quality of microgreens with specific substrates increasing chlorophyll levels.

Taste and aroma ratings are significant to microgreens consumers, as management techniques and production systems can influence these attributes (Wieth et al., 2019). A high TDS reflects superior flavor and aroma (Sobreira et al., 2010; Maciel et al., 2015). This study achieved high TDS values in the microgreen pea shoots grown in cocopeat media (4.5 °Brix), broccoli, and the pea shoot grown in rockwool media at 5.25 and 4.75 °Brix, respectively.

The choice of growing medium affects morphological traits, such as root and shoot development, which in turn affects nutrient uptake and TDS. The media with higher porosity and water retention, such as cocopeat and rockwool, produce microgreens with higher TDS levels (Saleh et al., 2022). Various growing media, such as cocopeat and vermicast, show different nutrient release patterns. For example, cocopeat increases nutrient availability, leading to higher TDS values in microgreens (Gunjal et al., 2024; Paillat et al., 2020).

A study on nitrogen-fertilized beets showed a positive correlation between chlorophyll content and total dissolved solids (°Brix), with a coefficient of determination exceeding 50% (Borges et al., 2017). This suggests that TDS increases along with chlorophyll, indicating enhanced photosynthetic activity and nutrient accumulation. The SPAD index, which measures chlorophyll content, was a reliable indicator of nitrogen demand and total chlorophyll, further linking chlorophyll to TDS through nutrient dynamics (Borges et al., 2017). Broccoli, similar to alfalfa, benefits from a nutrient-rich environment, leading to increased chlorophyll content and overall plant vigor, which correlates with higher TDS (Nair et al., 2011). It

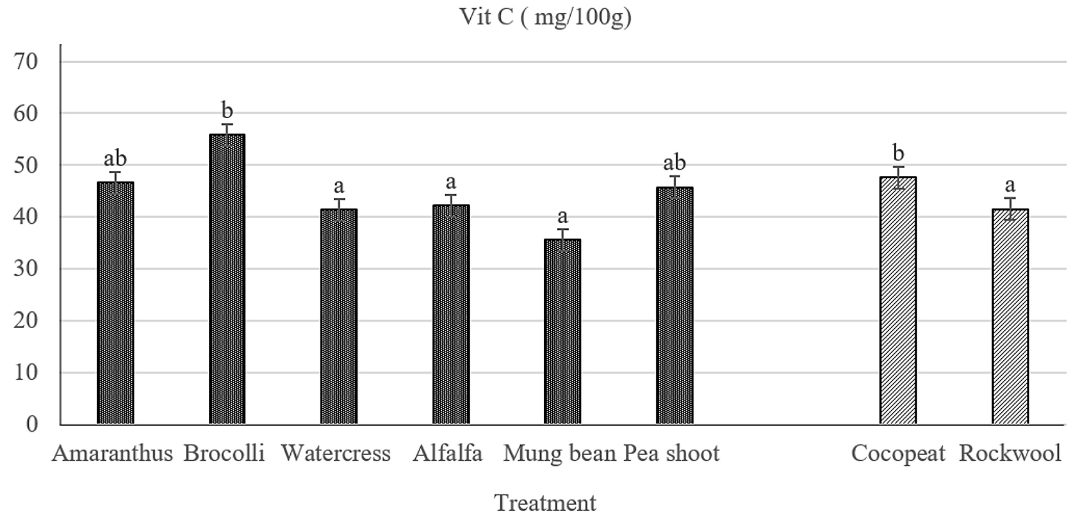


**Figure 4.** Vitamin C content of various microgreens on different media

is in line with the results of this study that broccoli and alfalfa have higher total chlorophyll than other microgreens.

The quality of microgreens is strongly influenced by the growing medium used (Weber, 2017; Treadwell et al., 2010; Murphy et al., 2010). Therefore, selecting suitable growing media is one of the most critical aspects of the microgreen production process. In this study, cocopeat media produced the highest vitamin C content (47.67 μg/g) compared to rockwool media (41.51 μg/g). When compared among microgreens, amaranthus and pea shoot microgreens have the vitamin C levels that almost match broccoli 46.64, 45.76, and 55.88 μg/g. This is in line with the research conducted by (Di Bella et al., 2020), which produced the highest vitamin C content in microgreen broccoli and higher than the vitamin C content in alfalfa (Kathi et al., 2023; Uher et al., 2023).

## CONCLUSIONS

This report provides details on the use of plentiful trash from the coconut industry in several nations as well as making microgreens from species easily found in the community. This research is in line with the trend of urban agriculture especially in Indonesia, addressing land scarcity and promoting indoor cultivation of nutrient-rich crops, which is crucial for food security in urban environments, and companies dealing with the issues related to environmental contamination. Considering all things, the evaluation results show that cocopeat media is more suitable for cultivating microgreens for any seed. This current research is expected to provide new insights into the potential use of such growing media in the cultivation of microgreens, as well as its contribution to improving the nutritional value and flavor of the crops.

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