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Optimization of Growing Media to Support Microgreens Growth and Nutritional Profile

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Abstract. Microgreens are young seedlings of edible vegetables, herbs, and flowers. Growing media plays a vital role in plant growth and the biosynthesis of multiple metabolites that improve the nutritional profile of microgreen. This study evaluated the effect of growing media from a combination of soil, husk charcoal, and perlite with a specific ratio of 1:1:1 (SHP 111), 2:1:1 (SHP 211), 1:2:1 (SHP 121), and 1:1:2 (SHP 112) on the nutrition profile and fresh weight of several microgreen plants, including water spinach, red spinach, green mustard, red lettuce, green spinach, and bok choy. The nutrient contents of nitrogen, phosphorus, and potassium in the growing media were quantified in this study. The data analysis was performed using Duncan's multiple range test to assess the quantity of vitamin A, vitamin C, antioxidant capacity, and fresh weight at a 5% confidence level. The results showed that SHP121 media exhibited moderate levels of nitrogen (0.23%), very high phosphorus (238.68 ppm), and high potassium (324.69 ppm. The highest vitamin A was found in red spinach in SHP111 (27.77 mg 100 g^{-1}) and SHP112 (22.72 mg 100 g^{-1}) media. The highest vitamin C was found in green mustard in SHP111 media (66.44 mg 100 g^{-1}) and in bok choy in SHP112 media (61.25 mg 100 g^{-1}). The highest antioxidant capacity was found in Bok choy in SHP121 media (386.4 mg AAEAC 1000 g^{-1}) and the highest fresh weight was found in water spinach in SHP121 media (4.03 g). In conclusion, SHP121 media can be recommended to support the balanced growth and nutritional quality of microgreen plants, especially bok choy, and water spinach. This study provides insights into how specific combinations of growing media can enhance the growth and nutritional content of microgreens. Future studies could focus on optimizing nutrient levels and environmental conditions to maximize the antioxidant properties and other bioactive compounds in microgreens.

Keywords: antioxidant; husk charcoal; perlite; soil; vitamin

INTRODUCTION

Microgreens are young seedlings of edible vegetables, herbs, and flowers. Research on microgreens has significantly increased in recent years due to the nutritional profile and health benefits offered by microgreens. Microgreens are harvested shortly after germination, generally within 10 to 20 days, and are known to contain higher concentrations of vitamins, minerals, and bioactive compounds compared to mature plants (Johnson et al., 2021; Puccinelli et al., 2019; Weber, 2017). The high antioxidant content of microgreens underlies much interest in these plants. Various studies have shown that microgreens exhibit various pharmacological activities arising from their antioxidant properties, such as anti-inflammatory and anti-diabetic (Balázs et al., 2023; Bhaswant et al., 2023; Tallei et al., 2024). Research suggests that microgreens can serve as functional foods, contributing positively to human health and nutrition (Muftiyatunnisa et al., 2023; Renna & Paradiso, 2020).

Several factors significantly affect microgreen growth, including light quality and intensity, growing medium, nutrient availability, and environmental conditions. The choice of growing medium plays a vital role in supporting plant growth, nutrition, and antioxidant properties. Substrates with varying nutrient concentrations can impact nutrient uptake, overall plant health, and the bioactive compounds produced. Research indicates that low-nutrient substrates can help manage nutrient levels effectively, leading to better control of the greenery's nutrient content (Di Gioia et al., 2017). Additionally, organic matter such as compost can improve growth and nutritional quality (Poudel et al., 2023). Interactions between growing media and nutrient solutions can also enhance growth parameters such as fresh weight and

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specific bioactive compounds (Septirosya et al., 2024). Studies have shown that a balanced nutrient solution improves the yield and nutritional profile of microgreens, although careful monitoring is needed to avoid excessive nitrate accumulation, which is common in certain species (Li, Lalk, & Bi, 2021; Li, Lalk, Arthur, et al., 2021). Furthermore, modulation of environmental factors during early growth stages significantly influences the morphology and phytochemical content of microgreens, enabling customized production strategies to meet market demands (Amitrano et al., 2023; Sharma et al., 2023).

The selection of a suitable growing medium is critical to the success of microgreen cultivation, as it directly affects their growth, yield, and nutritional quality. Soil is a common growing medium that provides a natural source of nutrients and supports microbial activity, promoting plant growth. However, using pure soil can sometimes limit the growth of certain plants, such as mustard greens, which exhibit poor growth in pure soil compared to other growing media combinations. While organic matter in the soil can increase moisture retention and nutrient availability, it may also cause issues like compaction and poor drainage if not properly managed

Husk charcoal, derived from the carbonization of agricultural residues, is beneficial in microgreen production due to its ability to improve aeration, drainage, and moisture retention essential factors for germination and plant growth. While husk charcoal is often produced as a by-product of burning organic materials like coconut husks for fuel or energy, it differs from biochar, which is specifically produced for environmental and agricultural applications. Biochar is created under controlled conditions at lower temperatures to preserve its carbon structure, improving soil health and promoting carbon sequestration (Roberts et al., 2010). In contrast, husk charcoal is primarily used to enhance plant growth, as it helps retain moisture and nutrients while improving root development. Studies have shown that husk charcoal can increase chlorophyll and carotenoid content in plants, improving their nutritional quality (Charloq, 2024). In this region, coconut husks are the main material used in husk charcoal production, selected for their abundance and effectiveness in supporting sustainable agricultural practices.

Perlite, a volcanic glass widely used in horticulture, is known for its lightweight properties and excellent drainage capabilities. It prevents soil compaction and provides aeration to the root zone, supporting healthy plant growth. Research suggests that adding perlite to growing media reduces the negative effects of high electrical conductivity (EC) and salinity levels, improving plant height and overall growth. Additionally, perlite supports the growth of various greens, including kale and arugula, especially when combined with organic substrates (Saleh et al., 2022). Its ability to retain moisture while facilitating drainage makes it ideal for use in soil-less and hydroponic systems (Bhaswant et al., 2023).

The use of soil, husk charcoal, and perlite as growing media for microgreens offers distinct advantages that can improve growth and nutritional quality. Soil provides a natural source of nutrients, husk charcoal improves aeration and moisture retention, and perlite ensures excellent drainage and prevents compaction. An optimal combination of these media can produce successful greenery, maximizing crop yields and health benefits. This study was conducted to evaluate the effect of planting media consisting of soil, husk charcoal, and perlite with a specific ratio on the growth of several microgreen plants, including water spinach (*Ipomoea aquatica* Forssk.), red spinach (*Amaranthus dubius* Mart.), green mustard (*Brassica juncea (*L.*)* Czern.), red lettuce (*Lactuca sativa* L.), green spinach (*Amaranthus viridis* L.), and bok choy (*Brassica rapa* L.).

The effect of growing media was evaluated through several nutritional parameters, including vitamin C content,

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vitamin A, antioxidant capacity, and fresh weight.

METHODS

The study was conducted in August - October 2024 at Udayana University using planting space boxes with dimensions of 35 cm × 35 cm × 20 cm. The planting room box temperature during the study ranged from 25 - 29 C. The study was designed using a Factorial Experiment with the basic design of Randomized Block Design (RBD), where the two factors were the type of microgreens and the planting media. The first factor was the type of microgreens, which included water spinach (*Ipomoea aquatica* Forssk.), red spinach (*Amaranthus dubius* Mart.), green mustard (*Brassica juncea (*L.*)* Czern.), red lettuce (*Lactuca sativa* L.), green spinach (*Amaranthus viridis* L.), and bok choy (*Brassica rapa* L.). The second factor was the planting media composition, which consisted of a combination of soil, husk charcoal, and perlite in the following ratios: 1:1:1 (SHP111), 2:1:1 (SHP211), 1:2:1 (SHP121), and 1:1:2 (SHP112). Each treatment was replicated three times.

Plant growth and harvest

Planting was carried out by preparing planting media containing soil, husk charcoal, and perlite. Planting media were weighed according to the predetermined composition by volume percentage per volume (v/v), then 1 kg of each media was put into planting containers and labeled. 3 grams of seeds were planted per container after sowing in the planting media and then covered. The planted seeds were left without lighting for one 24-hour period to increase seed germination. Planting box placed in a UV-coated paranet room. Maintenance carried out from planting to harvest is watering. Watering is done from planting to harvesting by spraying once every morning. The plants were harvested on the 14th day of planting. Microgreens are harvested by cutting microgreens as high as one centimeter above the soil line using scissors or sharp cutting tools.

Evaluation of Total N, available P and K and moisture content of the growing medium

We measured the nitrogen (N), phosphorus (P), and potassium (K) content in the growing medium before planting. The analysis was conducted after mixing the soil with different growing media materials at varying ratios. Nitrogen content is determined by the Kjeldahl method (Bremner, 1979), phosphorus content by UV-VIS spectrophotometry (Shimadzu) (Murphy & Riley, 1958), and potassium content using atomic absorption spectroscopy (AAS) (Knudsen et al., 1982).

For nitrogen analysis, approximately 0.5–1 gram of the growing medium sample was added to a mixture of sulfuric acid (H_2SO_4) and copper sulfate catalyst in a digester tube and heated to a clear solution to convert nitrogen to ammonium sulfate. A strong base (NaOH) is added to the digestion solution; then the resulting ammonia is distilled into a boric acid solution. The boric acid solution containing ammonia is titrated to calculate the nitrogen content with an acid standard solution (H_2SO_4) (Bremner, 1979).

For phosphorus analysis we used Bray-1, the growing medium samples were extracted using Bray solutions. Extract solutions are mixed with ammonium molybdate reagents, forming yellow complexes. The absorbance of the complex is measured with a spectrophotometer at a wavelength of 420-660 nm. Phosphorus content was calculated based on the standard curve (Murphy & Riley, 1958).

For potassium analysis, the growing medium samples were extracted using an ammonium acetate solution (1N) to release the available potassium. Potassium in the extract solution was analyzed using AAS at a wavelength of 766.490 nm, which measured the intensity of light absorbed by the potassium atoms in the solution. Potassium concentration was calculated based on a

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standard curve with pure potassium solution (Knudsen et al., 1982).

The moisture content of the media was determined using the gravimetric method by heating the sample in an oven at 105°C for 24 hours or until the weight was constant. After drying, the samples were cooled in a desiccator. The formula for calculating water content is presented in Equation 1 (Klute A., 1965).

$$\text{Water content} = \frac{A-B}{B} x\ 100\% \quad \ldots\ldots. 1)$$

A: Wet weight (g)
B: Dry weight (g)

Evaluation of Fresh Weigh, Vitamin A, Vitamin C, and Antioxidant Capacity

The fresh weight of microgreens was measured after harvesting; weighing was done by taking microgreens in plastic tubs of each treatment, including stems, cotyledon leaves, and true leaves. The fresh weight of microgreens was weighed using analytical scales in grams (g).

Vitamin C extraction and analysis were performed concerning Sérino et al., (2019) and Stevens et al., (2006). Vitamin C was extracted using 6% trichloroacetic acid. A total of 20 µL of extractant from each sample was added into a microplate and reacted with dithiothreitol, N-ethyl maleimide, and color reagents in the order they were obtained, and absorbance was recorded at 550 nm.

The sample was extracted by soxhletation using 100 ml of acetone then refluxed with petroleum ether 3x as much as 35 ml, the filtrate was then saponified with 15% KOH as much as 20 ml and allowed to stand overnight. The saponification results were re-extracted with petroleum ether 3 times as much as 25 ml in a separating funnel, washed with distilled water, and then dried with anhydrous Na2SO4. A blank solution was prepared with 10ml of N-hexane. Vitamin A standard solution was measured at a wavelength of 610 - 628 nm. The vitamin A value was determined based on the vitamin A standard curve.

Antioxidant capacity analysis was performed the using DPPH (1,1-diphenyl-1-picrylhydrazyl) method. Preparation of 0.1 mM DPPH was carried out by dissolving 4 mg DPPH in 1000 ml methanol. The 1000 ppm extract was prepared by weighing 12.5 mg of extract, dissolved in 1250 l dimethyl sulfoxide, heated until dissolved, and vortexed. The antioxidant activity test was carried out by taking 50 µl and putting it into a test tube, adding 450 µl of methanol, then adding 3 ml of DPPH solution, vortexed until homogeneous, allowed to stand for 30 minutes in a closed and dark room. The absorbance was measured on UV-vis spectrophotometry with a wavelength of 517 nm.

Antioxidant vitamin C test was done by dissolving 20 mg of vitamin C in 100 ml of 96% ethanol. Solutions were made with several concentrations, namely 500 µl, 400 µl, 300 µl, 200 µl, 100 µl methanol were added to each concentration. Then, 3 ml of DPPH solution was added, and the absorbance was measured using UV-Vis spectrophotometry with a wavelength of 517 nm. Percent inhibition of the sample was calculated using the formula as presented in Equation 2 (Blois, 1958):

$$\text{Percentage of inhibition (\%)} = \frac{A-B}{A} \text{ x } 100\% \quad \ldots\ldots. 2)$$

A : Absorbance of blanko
B : Absorbance of sample

Vitamin C and A content values are expressed as mg/100 g fresh weight while antioxidant capacity is expressed as mg Ascorbic acid equivalent antioxidant capacity (AAEAC)/1000 g.

Data Analysis

Data were subject to analysis of variance. Significant differences between treatments were separated by Duncan's Multiple Range Test. $P < 0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

In this study, several compositions of microgreen plant media were evaluated on the growth and nutritional parameters of

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several microgreen plants. In this study, the planting media used was a combination of soil, husk charcoal, and perlite in a specific ratio. Test results on nitrogen (N), phosphorus (P), and potassium (K) content (Table 1) showed that SHP121 media had moderate levels of nitrogen (0.23%), very high phosphorus (238.68 ppm), and high potassium (324.69 ppm), which was the best combination to support various nutritional parameters of microgreen plants. SHP211 and SHP112 media have very low nitrogen levels but still perform well in certain crops. The choice of growing media significantly influences microgreens' growth, nutritional quality, and antioxidant activity. Various substrates, including soil, husk charcoal, and perlite, have been studied for their effects on fresh weight and nutritional content, particularly vitamins A and C, and overall antioxidant activity.

Table 1. The quantity of nutrients in the growing media

Media	Nitrogen (%)	Phosphor (ppm)	Potassium (ppm)	Water content (%)
SHP 111	0.17 (L)	234.98 (VH)	254.85 (H)	2.93
SHP211	0.02 (VL)	192.10 (VH)	298.73 (H)	2.48
SHP121	0.23 (M)	238.68 (VH)	324.69 (H)	3.90
SHP112	0.11 (L)	127.97 (VH)	250.52 (H)	2.21

Note: The letter following the number in the NPK level indicates the quantity of nutrients in the soil.
The classification for each parameter, such as nitrogen, phosphorus, and potassium, is categorized based on the following levels: L (low), VL (very low), M (moderate), H (high), and VH (very high), as outlined by Balai Pengujian Standar Instrumen Tanah dan Pupuk (2023).

Nitrogen (N), phosphorus (P), and potassium (K) are essential macronutrients that play an important role in plant growth and nutrition. Each nutrient contributes uniquely to various physiological processes, and their availability can significantly affect plant health, yield, and nutritional quality. Nitrogen is essential for plant growth as it is a critical component of amino acids, proteins, nucleic acids, and chlorophyll, which are essential for photosynthesis and overall plant metabolism (Bellamkonda, 2022; Wu et al., 2023; Yang et al., 2023). Phosphorus (P) is another essential nutrient that supports various metabolic processes, including energy transfer through ATP (adenosine triphosphate) and nucleic acid synthesis. Phosphorus is essential in root development, and flowering is critical for reproductive success and crop yield (Manaroinsong et al., 2014). Potassium (K) regulates various physiological processes, including osmoregulation, enzyme activation, and photosynthesis. Potassium increases plant resistance to stress conditions such as drought and disease, thereby improving overall plant health and productivity. Potassium also plays a role in protein and starch synthesis, contributing to the nutritional quality of harvested products (Jansen et al., 2015; Manaroinsong et al., 2014).

The nutrient profile and fresh weight of microgreens are shown in Table 2 and Figure 1. The highest vitamin A content was found in red spinach (RS) in SHP111 (27.77 mg/100 g) and SHP112 (22.72 mg/100 g) media, the highest vitamin C was found in green mustard (GM) in SHP111 (66.44 mg/100 g) media and bok choy (BC) in SHP112 (61.25 mg/100 g) media, and the highest antioxidant capacity was produced by the use of SHP 121 media on bok choy (BC) (386.4 mg AAEAC/1000 g). The plant with the highest fresh weight was water spinach (WS) on SHP121 media (4.03 g), indicating optimal growth performance on this media.

In this study, SHP121 growing medium in bok choy plants produced the highest antioxidant capacity. SHP121 showed high potassium levels in the media. Several studies have shown a correlation between high potassium levels and increased production of secondary metabolites, including phenolic compounds and flavonoids, known for their antioxidant properties. Research by Gan et al., (2010) showed a positive correlation

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between total antioxidant capacity and phenolic content in traditional medicinal plants, indicating that phenolic compounds significantly contribute to the antioxidant capacity of these plants. Another study showed that high potassium levels can increase the accumulation of phenols in *Allium schoenoprasum*, which contributes to an increase in antioxidant capacity (Štajner et al., 2011). Potassium has also been shown to increase the synthesis of glucosinolates, which are bioactive compounds with antioxidant properties. Research shows that potassium can enhance glucosinolate synthesis in Chinese kale, contributing to the plant's antioxidant capacity (Chang et al., 2019). This relationship underscores the importance of potassium in promoting the synthesis of beneficial phytochemicals that enhance antioxidant activity.

All growing media used in this study contained high levels of phosphorus and potassium nutrients. Studies have shown that adequate phosphorus and potassium levels can enhance plant growth and increase vitamin and antioxidant production. Potassium in plant media can increase phosphorus nutrients and overall nutrient uptake, which is very important for synthesizing essential compounds, including vitamins (Han et al., 2023).

Vitamin A, mainly in the form of carotenoids, is synthesized in plants through metabolic pathways that require sufficient phosphorus for energy transfer and potassium for enzyme activation. Research has indicated that higher potassium levels can enhance carotenoid synthesis, increasing vitamin A content in crops such as tomatoes (Jędrszczyk, 2010). Similarly, phosphorus has been shown to play a role in ascorbic acid (vitamin C) accumulation in various plant species, as it is involved in the biosynthetic pathways that produce this essential nutrient (Singh et al., 2022). Both phosphorus and potassium contribute to the antioxidant profile of plants by influencing the production of antioxidant compounds and enzymes. The presence of phosphorus and potassium can increase the activity of antioxidant enzymes such as superoxide dismutase (SOD) and catalase (CAT), which are essential for reducing oxidative stress (Fernandes et al., 2014). Research shows that applying phosphorus and potassium fertilizers positively affects the nutrient status in winter triticale plants, leading to increased antioxidant levels (Gaj, 2012). Moreover, the interaction between these nutrients can increase the production of secondary metabolites, such as phenolics and flavonoids, known for their antioxidant properties (Arbačauskas et al., 2023).

Soil as a growing medium provides essential nutrients and supports microbial activity, enhancing plant growth and nutrient uptake. Research shows that different soil types can lead to variations in crop yields and nutrient profiles. Research shows that soil physicochemical properties, such as pH and organic matter content, directly affect the availability of nutrients such as calcium and magnesium, which are critical for plant health (D'Imperio et al., 2021; Poudel et al., 2023). The microbial community in the soil also plays an essential role in nutrient cycling, thus affecting the overall quality of the greens (Chang et al., 2019; Mariam Paul & Harikumar, 2021). In addition, organic matter in the soil can improve water retention and aeration, which is essential for healthy root development (Bulgari et al., 2021).

The use of husk charcoal as a growing medium can improve its physical properties, such as aeration and drainage. Husk charcoal has porous properties that improve moisture retention while preventing soil compaction, which is essential for root growth. Studies have shown that using husk charcoal as part of the growing medium can increase the fresh weight and improve the nutrient content of green vegetables, especially vitamin content and antioxidant activity (Bayineni & Herur N, 2022; Liu et al., 2020). Charcoal can also improve the overall nutrient profile of greens (Tallei et al., 2024).

Perlite, another common substrate, is known for its lightweight and sterile

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characteristics, making it an excellent choice for green vegetable cultivation. Its high porosity promotes excellent drainage and aeration, crucial for preventing root rot and ensuring healthy plant growth. Studies have shown that greens grown in perlite-based media often exhibit higher fresh weights and increased vitamin A and C levels than those grown in traditional soil (Li, Lalk, & Bi, 2021; Renna & Paradiso, 2020). Perlite can also facilitate better nutrient absorption, increasing antioxidant activity in harvested microgreens (Sharma et al., 2023).

Table 2. The nutrient profile and fresh weight of microgreens

Treatment		Vitamin A (mg 100 g^{-1} fresh weight)	Vitamin C mg 100 g^{-1} fresh weight)	Antioxidant Capacity (mg AAEAC 1000 g^{-1})	Fresh Weight (g)
WS	SHP 111	12.5 ± 0.16^{l}	23.88 ± 0.36^{u}	246.01 ± 3.75^{f}	2.37 ± 0.17^{d}
	SHP211	14.87 ± 0.19^{i}	29.08 ± 0.44^{q}	205.23 ± 3.13^{j}	3.66 ± 0.12^{b}
	SHP121	11.77 ± 0.15^{p}	25.02 ± 0.38^{s}	215.33 ± 3.28^{h}	4.03 ± 0.20^{a}
	SHP112	17.61 ± 0.22^{f}	23.81 ± 0.36^{u}	198.92 ± 3.02^{l}	3.25 ± 0.06^{c}
RS	SHP 111	27.77 ± 0.35a	34.68 ± 0.53^{n}	201.91 ± 3.08^{k}	0.08 ± 0.01^{l}
	SHP211	24.11 ± 0.30^{b}	52.19 ± 0.79^{e}	178.47 ± 2.72^{q}	0.15 ± 0.04^{j}
	SHP121	13.48 ± 0.17^{j}	27.36 ± 0.42^{r}	170.51 ± 2.60^{r}	0.14 ± 0.03^{j}
	SHP112	22.72 ± 0.29^{c}	58.61 ± 0.89^{c}	197.27 ± 3.00^{m}	0.11 ± 0.02^{l}
GM	SHP 111	11.85 ± 0.15^{p}	66.44 ± 1.01^{a}	318.62 ± 4.85^{b}	0.48 ± 0.19^{f}
	SHP211	14.87 ± 0.19^{i}	24.39 ± 0.37^{t}	266.02 ± 4.05^{d}	0.61 ± 0.09^{f}
	SHP121	12.33 ± 0.15^{m}	34.48 ± 0.52^{o}	286.57 ± 4.36^{c}	0.54 ± 0.05^{f}
	SHP112	17.62 ± 0.22^{f}	35.85 ± 0.54^{m}	212.73 ± 3.24^{i}	0.55 ± 0.09^{f}
RL	SHP 111	12.01 ± 0.15^{o}	32.54 ± 0.50^{p}	183.34 ± 2.79^{o}	0.3 ± 0.03^{i}
	SHP211	10.49 ± 0.13^{r}	38.5 ± 0.59^{k}	180.7 ± 2.75^{p}	0.34 ± 0.01^{h}
	SHP121	8.2 ± 0.11^{t}	45.32 ± 0.69^{h}	213.65 ± 3.25^{i}	0.31 ± 0.02^{i}
	SHP112	11.02 ± 0.14^{q}	44.75 ± 0.68^{i}	245.79 ± 3.74^{f}	0.42 ± 0.09^{g}
GS	SHP 111	17.04 ± 0.21^{g}	$45.35 \pm 0.69_{h}$	190.95 ± 2.91^{n}	0.1 ± 0.02^{l}
	SHP211	20.64 ± 0.26^{e}	$32.83 \pm 0.50_{p}$	206.52 ± 3.15^{j}	0.14 ± 0.02^{k}
	SHP121	9.32 ± 0.12^{s}	48.66 ± 0.74^{g}	147.69 ± 2.25^{s}	0.11 ± 0.01^{l}
	SHP112	21.17 ± 0.27^{d}	50.95 ± 0.77^{f}	257.86 ± 3.93^{e}	0.09 ± 0.02^{l}
BC	SHP 111	12.25 ± 0.16^{n}	43.44 ± 0.66^{j}	216.8 ± 3.30^{h}	0.54 ± 0.04^{f}
	SHP211	16.73 ± 0.21^{n}	37.75 ± 0.58^{l}	233.2 ± 3.55^{g}	0.6 ± 0.04^{f}
	SHP121	9.3 ± 0.12^{s}	55.48 ± 0.84^{d}	386.4 ± 5.88^{a}	0.51 ± 0.06^{f}
	SHP112	13.12 ± 0.17^{k}	61.25 ± 0.93^{b}	265.35 ± 4.04^{d}	0.41 ± 0.04^{g}

Note: Data showed in mean ± deviation standard (n=3). Numbers followed by the same letters in the same group (vitamin C, vitamin A, antioxidant capacity, and fresh weight) show no significant difference based on Duncan test at 5% level. WS (water spinach); RS (red spinach); GM (green mustard); RL (red lettuce); GS (green spinach); BC (Bok choy).

The selection of growing media, including soil, husk charcoal, and perlite, plays an essential role in determining microgreens' fresh weight and nutritional quality. Each medium affects the availability of essential nutrients and overall growing conditions, affecting vitamin A and C levels and the antioxidant activity of the plants (Di Gioia et al., 2017; Weber, 2017). Understanding these interactions can help optimize microgreen production to enhance nutritional benefits.

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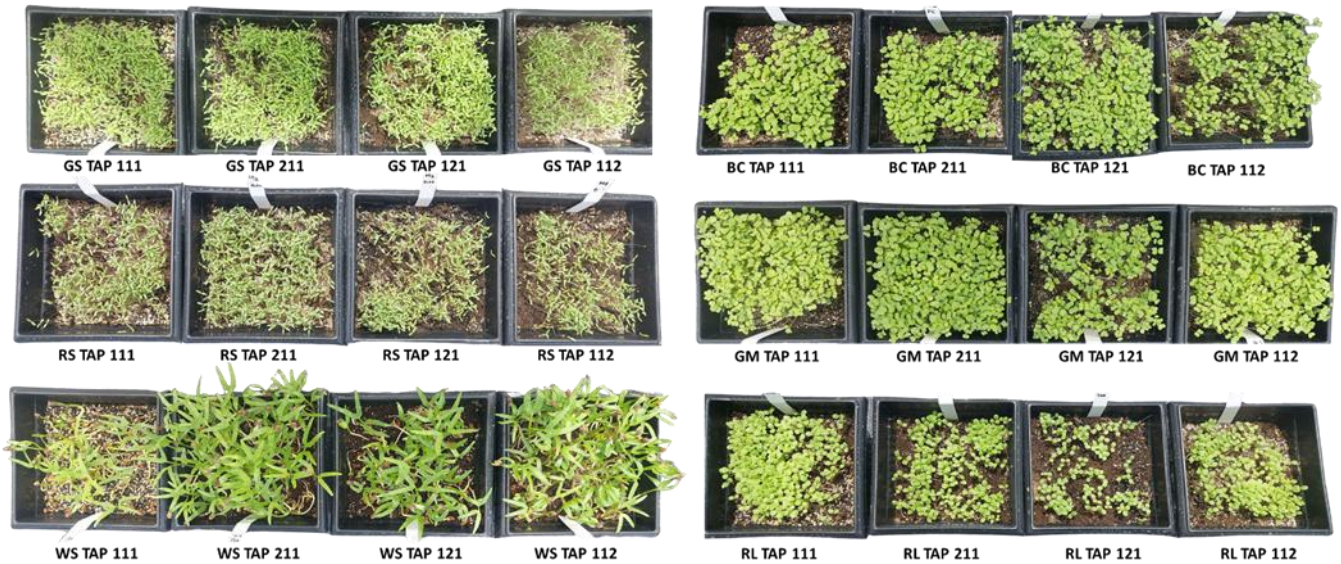

Figure 1. Microgreens grown on different media (SHP 111, SHP211, SHP 121, SHP112) on WS (water spinach), RS (red spinach), GM (green mustard), RL (red lettuce), GS (green spinach), BC (Bok choy).

CONCLUSION

The combination of soil, husk charcoal, and perlite in this study can be used as a growing medium for microgreens. However, this combination of planting media fulfils the needs of phosphorus and potassium elements but still has a low nitrogen nutrient content. In this study, SHP121 media can be recommended to support the balance of growth and nutritional quality of microgreen plants, especially for bok choy and water spinach. This research contributes to the understanding of how different growing media combinations affect the growth and nutritional profile of microgreens, providing valuable insights for optimizing microgreen production in controlled environments. Future studies could focus on refining nutrient ratios in growing media, investigating the impact of environmental factors, and exploring the potential for biofortification of microgreens to enhance their health benefits."

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