Optimizing Soilless Media for Superior Microgreen Production and Sensory Acceptance

ABSTRACT

Microgreens, the young and nutrient-dense shoots of vegetables and herbs, represent a remarkable innovation in both agriculture and culinary arts. This study investigates the optimal growing media for microgreens of Red Amaranthus, Fenugreek, and Spinach by comparing cocopeat and cocopeat + vermicompost mixtures. The growth performance, including plant height and yield, was assessed at intervals of 5, 10, and 15 days. Red Amaranthus microgreens showed significantly higher growth in cocopeat-vermicompost (6.66 cm on the 15th day) compared to cocopeat alone (5.03 cm). Similar trends were observed in Fenugreek and Spinach, with the cocopeat-vermicompost mix enhancing both fresh and dried weights. For instance, Fenugreek grown in the mix had a fresh weight of 203.66 g versus 141.33 g in cocopeat. Spinach microgreens followed the same pattern, showing improved growth metrics. The study highlights the superior growth and yield of microgreens in cocopeat-vermicompost due to enhanced nutrient availability. Sensory evaluation by a panel of 99 participants revealed diverse flavor profiles, with Red Amaranthus exhibiting balanced grassy notes and Fenugreek having a strong, intense flavor. Spinach microgreens were milder, making them more palatable to a wider audience. These findings suggest that incorporating vermicompost into the growing medium significantly improves microgreen production and consumer acceptability.

Keywords: ***Microgreens, Growing media, Cocopeat, Vermicompost, Nutrient availability, Red Amaranthus, Fenugreek, Spinach, Sensory evaluation, Consumer acceptance.***

INTRODUCTION

Microgreens are young, edible plants harvested at the cotyledon stage, usually 7 to 21 days after germination. Renowned for their vibrant colors, delicate textures and intense flavors, microgreens are much more than a culinary trend. They offer a unique combination of aesthetic appeal, diverse flavors, and substantial nutritional benefits, often containing higher concentrations of vitamins, minerals, and antioxidants compared to their mature greens. This makes microgreens a valuable addition to any diet, enhancing both

the visual and nutritional quality of various dishes.

The concept of microgreens is relatively new in agricultural history. While sprouts, a similar but not identical product, had been utilised for thousands of years, microgreens as we know them today began gaining popularity in the 1980s in California. Initially, they were embraced by chefs looking to add color, texture, and flavor to their dishes. Over the decades, microgreens had moved from being a niche product to a mainstream one, valued for both their nutritional benefits and ease of cultivation [8-10].

Microgreens are not only nutritionally rich but also environmentally friendly. They require less water and space compared to traditional crops, making them an ideal choice for sustainable agriculture. The short growth cycle of microgreens also means they can be harvested multiple times throughout the year, providing a continuous supply of fresh produce.

In the context of urban farming, microgreens offer a viable solution to the food production in densely populated areas. They can be grown in small spaces such as rooftop gardens or indoor farms, making them accessible to urban dwellers with limited gardening space. Vertical farming, which involves multitier cropping systems, can maximize the yield per square meter of land, addressing the increasing popularity for fresh food without overburdening agricultural land (Beacham *et al*., 2019).

MATERIAL AND METHODS

The present research was carried out in the department of Food Science and Nutrition, University of Agricultural Sciences, GKVK, Bengaluru, India. The study was conducted during the academic year 2023-2024.

Procurement of Raw materials

Microgreens such as red amaranthus, fenugreek and spinach were grown in the University of Agricultural Sciences, GKVK, Bangalore. The mature greens are procured from the Bangalore local market.

Growing Medium

Growing media were used as substrates, which were only cocopeat and cocopeat with

vermicompost in 1:1 ratio. All crops were sown in perforated trays (size 45× 52 × 4cm).

Sowing Microgreen Seeds

15g of seeds are sowed per tray. Uniform distribution of seeds was ensured. The trays are then kept in the nursery of the department of horticulture, UAS, GKVK, Bangalore.

Harvesting of Microgreens

15th days after seedlings microgreens were harvested by cutting just above the media surface through sterilized scissors.

Sensory attributes of microgreens

Evaluated intensity of sensory attributes (aroma, astringency, bitterness, grassy, h eat, sourness, sweetness) using a nine-
category horizontal line scale (1 = none, 9 = strongest imaginable) of red amaranthus, fenugreek and spinach microgreens. Overall acceptability and liking of appearance, texture, and flavor were assessed using a nine-point hedonic scale (1 = highly unacceptable, 9 = highly acceptable).

Morphological parameters of fresh Microgreens

Plant height

It was taken by the level of media surface to the growing tip. It was measured 5thday of the interval after sowing till the harvesting time. A total of ten of each microgreen were picked randomly then kept at resting position and using the scale length was calculated and the average was expressed in centimeters (cm).

Fresh weight of Microgreens

After harvesting the microgreens, fresh weight was taken per tray.

Statistical analysis

All the results were presented as mean ± standard deviation (SD). Independent samples t-tests were used for two-group comparisons. Statistical analyses were performed using SPSS 20.0 (IBM, USA).

RESULTS AND DISCUSSION

Selecting the growing media for microgreens

Microgreens of red amaranthus, fenugreek and spinach were grown in two different soilless media that was cocopeat and cocopeat +vermicompost. On the basis of the

morphological parameter such as height (Plate 1) at each interval, dry and fresh yield the best growing media was selected**.**

The growth performance of microgreens under different growth media conditions, such as cocopeat and cocopeat-vermicompost mix was evaluated over multiple intervals (5, 10 and 15th day).

Red Amaranthus: The height of red amaranthus microgreens was significantly influenced by the type of growth media. On the 5th day, the height was 2.66cm in cocopeat and 3.06cm in cocopeat + vermicompost, showing a slight but not significant improvement. By the 10th day, the growth in both media was more pronounced, with heights reaching 4.55cm and 4.7cm, respectively. On the 15th day, microgreens in cocopeat + vermicompost exhibited significantly higher growth (6.66cm) compared to those in cocopeat alone (5.03).

Fenugreek: Similar trends were observed in fenugreek microgreens. The height on the 5th day was 3.4cm in cocopeat and 3.5cm in cocopeat + vermicompost. On the 10th day, the heights increased to 4.2cm and 4.7cm, respectively. The 15th day showed significant growth in both media, with cocopeat + vermicompost having a slightly higher height (7.5cm) than cocopeat (7.35cm) grown microgreens.

Spinach: Spinach microgreens also showed significant differences in growth between the two media. On the 5th day, the heights were 2.75cm in cocopeat and 2.66cm in cocopeat + vermicompost. The growth was more noticeable by the 10th day, with heights of 3.11cm and 3.38cm, respectively. By the 15th day, microgreens in cocopeat + vermicompost reached 6.05cm compared to 4.80cm in cocopeat**.**

The result of the present study goes on par with the study of Gunjal *et al.,* 2024 where radish sango microgreens were shown a higher shoot height (5.66±1.36 cm) and width (1.33±0.08 mm) in the soilless growing medium.

Hoang *et al.* (2022) conducted the study where red cabbage, broccoli, mizuna, green mustard, and pak choi microgreens were grown in substrates including (sand, organic soil, coco coir, rice husk, white sphagnum peat, and vermiculite) with different formulations, the shoot height of 5.8 to 7.2 cm.

In another study by Dhaka *et al*. (2023), different selected crops including mustard (6 to 11 cm), pearl millet (7 to 12 cm), mung bean (7 to 14 cm), red radish (6 to 9 cm), lentil (8 to 12 cm), and red cabbage (7 to 9 cm), microgreens shoot height were observed

on the ninth days after sowing which was more than the microgreens from the present study. The height of microgreens can depend upon the media, environmental condition and also the species.

Saleh *et al*. (2023), evaluated the growth and biochemical composition of four microgreen species (kale, Swiss chard, arugula, and pak choi) grown in different mixed soilless media. The results showed that the soilless media combinations significantly improved plant growth, yield and biochemical composition.

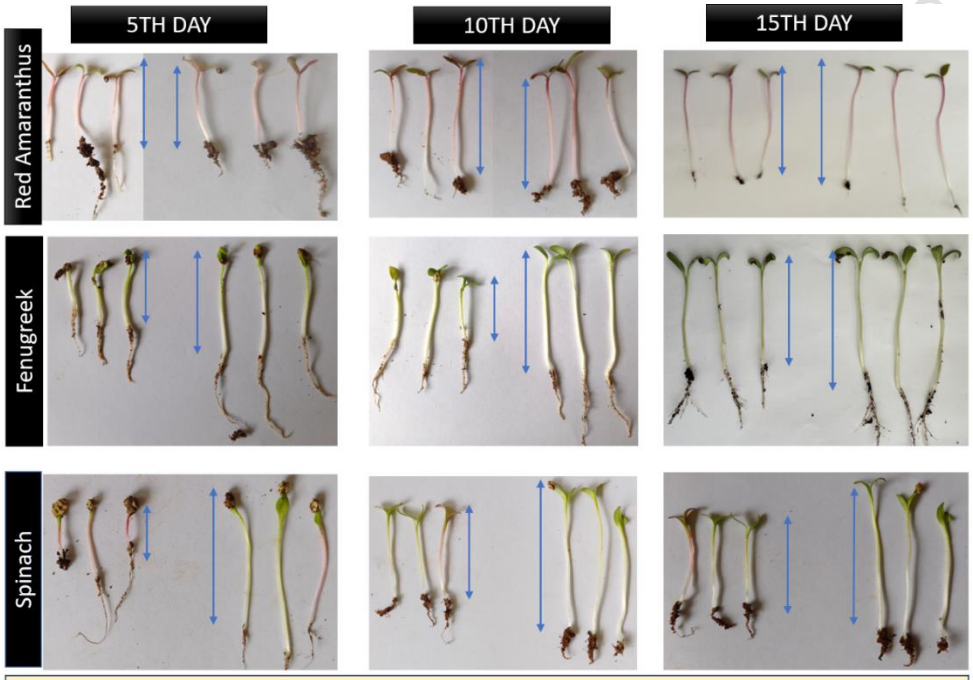

Plate1: Height comparison of microgreens grown in cocopeat and cocopeat + vermicompost

Plate 1: height comparison of microgreens grown in cocopeat and cocopeat+ vermicompost

Table 1: Height of the microgreens in different intervals grown in cocopeat and cocopeat +vermicompost.

I. Red Amaranthus (cm)		
Days	**Cocopeat**	**Cocopeat + Vermicompost**
5th day	2.66 ± 2.30[a]	3.06 ± 2.50[a]
10th day	4.55 ± 1.75[b]	4.7 ± 0.80[b]
15th day	5.03 ± 0.75[c]	6.66 ± 1.25[c]
II. Fenugreek (cm)		
Days	**Cocopeat**	**Cocopeat + Vermicompost**
5th day	3.4 ± 2.30 [a]	3.55 ± 3.50[a]
10th day	4.2 ± 1.20[b]	4.7 ± 2.03[b]
15th day	7.35 ± 0.65 [c]	7.5 ± 0.75 [c]
III. Spinach (cm)		
Days	**Cocopeat**	**Cocopeat + Vermicompost**
5th day	2.75 ± 1.50 [a]	2.66 ± 0.80 [a]
10th day	3.11 ±1.20 [b]	3.38 ± 1.30 [b]
15th day	4.80 ± 2.80 [c]	6.05 ± 2.67 [c]

The data presented in (**Table 2**) highlights the powder yield of different microgreens grown in cocopeat (C) and cocopeat-vermicompost mix (C+V). The results suggested significant differences in both fresh and dried weights across the two media types, indicating the beneficial impact of vermicompost on microgreen yield (**Plate 2**).

Red Amaranthus: The fresh weight of red amaranthus was notably higher when grown in C+V (155.94g) compared to C (94.83g). The dried weight followed a similar trend, with C+V showing a yield of 8.50g, significantly higher than the 4.92g recorded for just cocopeat grown microgreens.

Fenugreek: The fresh and dried weights of fenugreek also showed significant improvements in the cocopeat +vermicompost medium. The fresh weight in cocopeat +vermicompost was 203.66g, compared to 141.33g in cocopeat. Similarly, the dried weight in cocopeat +vermicompost was 11.44g, compared to 6.5g in cocopeat.

Spinach: For spinach, the cocopeat +vermicompost medium again outperformed cocopeat media, with fresh weights of 162.77g versus 125.11g, respectively. The dried weights also showed a marked difference.

On the basis of height of the plant and the yield of the microgreens, the microgreens grown in cocopeat +vermicompost was selected for the future study.

Overall, the addition of vermicompost to cocopeat not only increased the fresh and dried yields of the microgreens but also significantly enhanced their growth. These results suggested that incorporating vermicompost into the growing medium can substantially improve microgreen production, making it a valuable practice for optimizing yields.

This study was supported by previous research by Saleh *et al.* (2023) that also observed significant growth improvements in microgreens grown in mixed soilless media.

The morphological parameters (leaf length, leaf width, and leaf area) of microgreens grown in soilless and soil based growing media revealed distinct differences in growth characteristics. The soilless growing medium showed better results as compared to the control growing medium in the study of Gunjal *et al*. (2024).

The microgreens grown in cocopeat+vermicompost was considered the best growing media when compared to just cocopeat. So, the cocopeat + vermicompost grown microgreens were selected for further research.

Table 2: Powder yield for 10gm of seed per tray (Size: 45× 52 × 4 cm)

Growth media	Red Amaranthus		Fenugreek		Spinach	
	Fresh weight (g)	Dried weight (g)	Fresh weight (g)	Dried weight (g)	Fresh weight (g)	Dried weight (g)
C	94.83 ± 0.76	4.92 ± 0.88	141.33 ± 1.5	6.5 ± 0.20	125.11 ± 1.1	4.4 ± 0.46
C+V	155.94 ± 0.82	8.50 ± 0.5	203.66 ± 1.2	11.44 ± 0.50	162.77 ± 2.5	8.9 ± 0.40
t-value	94.37*	NS	54.34*	15.34*	23.29*	12.52*

C: Cocopeat, C+V Cocopeat + Vermicompost
Note: Values were expressed as mean ± standard deviation of three determinations.
*Significant at ($p \leq 0.01$), NS: not significant

Morphological parameters of fresh microgreens

The morphological parameters of fresh microgreens vary distinctly among red amaranthus, spinach, and fenugreek. Red amaranthus microgreens typically exhibited vibrant red stems and green leaves, with a delicate leafy structure. Fenugreek microgreens feature small, trifoliate leaves with a slightly lighter green color known for their elongated, slender stems. Spinach microgreens present dark green leaves with a slightly crinkled texture characterized by their broad and flat leaf shape. Each type of

microgreen displays unique visual characteristics.

Table 3 depicts the morphological parameters of fresh microgreens grown in cocopeat + vermicompost demonstrated notable variations across different microgreens.

Red Amaranthus: Exhibited a mean plant length of 5.5cm, with an average of 2.2 leaves per plant. The leaves were relatively short (0.3cm) and displayed a dark red-green color with a soft texture.

Fenugreek: Showed the highest mean plant length among the studied microgreens at 10.3cm. Each plant averaged 4.8 leaves and the leaves had a length of 0.6cm. The color was light green, and the texture was slightly rough.

Spinach: Had a mean plant length of 8.6cm with an average of 4.0 leaves per plant. The leaf length was 0.3, with the color being dark green and the texture smooth.

These morphological observations suggested that the growth medium significantly impacted the physical characteristics of the microgreens. The addition of vermicompost to cocopeat appears to enhanced the growth metrics, potentially due to the improved nutrient availability and soil structure provided by vermicompost.

This result was supported by the study conducted by Gunjal *et al.* (2024) where the beetroot microgreens showed a leaf length (0.77±0.15cm), a leaf width (0.16±0.08cm), and a total leaf area (0.10±0.06cm^2), while red amaranthus microgreens had a shorter leaf length (0.44±0.05cm), a similar leaf width (0.15±0.02cm), and a smaller total leaf area (0.05±0.01cm^2) were observed.

Plate 2: microgreens of Red amaranthus, Fenugreek and Spinach

Table 3: Morphological parameters of fresh microgreens grown in cocopeat + vermicompost

Morphological Parameters	Red Amaranthus (Mean ± SD)	Fenugreek (Mean ± SD)	Spinach (Mean ± SD)
Length of the plant (cm)	5.5 ± 0.8	10.3 ± 1.1	8.6 ± 0.7
Number of leaves per plant	2.2 ± 0.5	4.8 ± 0.4	4.0 ± 0.6
Length of leaves (cm)	0.3 ± 0.3	0.6 ± 0.4	0.3 ± 0.3
Colour of microgreens	Dark Red-Green	Light Green	Dark Green
Texture of microgreens	Soft	Slightly Rough	Smooth

Consumer sensory perception and acceptance of an emerging microgreens

The sensory perception, particularly the flavor and texture play a crucial role in consumer acceptance (DU M *et al*., 2022) . Microgreens with lower levels of astringency, sourness, and bitterness tend to be more acceptable to consumers. Additionally, their compact size and versatility in culinary applications make them a favourite among health-conscious individuals

Intensity of sensory attributes of microgreens

The intensity of sensory attributes of microgreens, a nine-category horizontal line scale was used, ranging from 1 (none) to 9 (strongest imaginable). Appearance typically scores high, between 6 and 8, due to vibrant colors. Flavor intensity varies, with scores from 5 to 8, reflecting diverse tastes. Texture scores ranged from 4 to 7, indicating freshness and crispness. Aroma, generally subtle, scores between 2 and 6. Overall acceptability, combining all attributes, often scores between 7 and 9, highlighting their popularity and consumer approval. These assessments help understand consumer preferences and enhanced microgreens' market appeal**.**

The sensory attributes of microgreens grown in cocopeat + vermicompost, as summarized in Table 4 reveal notable differences in taste profiles among red amaranthus, fenugreek, and spinach.

Red Amaranthus: Exhibited moderately strong aroma (6.5) and grassy notes (7.1),

with slight astringency (4.2 ± 0.3) and moderate bitterness (5.8 ± 0.4). The sourness (3.9 ± 0.3) and heat (3.4 ± 0.2) were comparatively weaker suggested a balanced flavor profile with a stronger grassy note.

Fenugreek: Had the highest ratings for bitterness (8.01 ± 0.5) and astringency (7.8 ± 0.6), indicating a strong, intense flavor. The aroma (5.3 ± 0.4) and grassy taste (6.4 ± 0.4) were moderately strong, while the heat (5.1 ± 0.3) and sourness (4.3 ± 0.2) provided a complex sensory profile.

Spinach: Showed a milder sensory profile with moderately weak aroma (5.1 ± 0.3) and grassy taste (6.2 ± 0.3). Astringency (3.5 ± 0.2) and bitterness (4.3 ± 0.2) were the lowest among the three, suggested a milder taste overall. The heat (2.7 ± 0.2) and sourness (3.8 ± 0.3) were also minimal, making spinach more palatable for a wider audience.

These sensory attributes, evaluated by a panel of 99 participants, highlight the diverse flavor profiles of microgreens grown in a cocopeat + vermicompost mixture.

Table 4: Intensity of sensory attributes of cocopeat + vermicompost grown microgreens (n=99)

Microgreens	Aroma	Astringency	Bitterness	Grassy	Heat	Sourness
Red Amaranthus	6.5 ± 0.5	4.2 ± 0.3	5.8 ± 0.4	7.1 ± 0.3	3.4 ± 0.2	3.9 ± 0.3
Fenugreek	5.3 ± 0.4	7.8 ± 0.6	8.01 ± 0.5	6.4 ± 0.4	5.1 ± 0.3	4.3 ± 0.2
Spinach	5.1 ± 0.3	3.5 ± 0.2	4.3 ± 0.2	6.2 ± 0.3	2.7 ± 0.2	3.8 ± 0.3

Notes: Scored on a nine-category horizontal line scale with verbal magnitude anchor labels ranging from 1 = none, 2 = extremely weak, 3 = moderately weak, 4 = slightly weak, 5 = neither weak nor strong, 6 = slightly strong, 7 = moderately strong, 8 = extremely strong, 9 = strongest imaginable.

Evaluation of sensory characteristics of microgreens

Table 5: Sensory score for microgreens

Sensory attributes	Red Amaranthus	Fenugreek	Spinach
Appearance	8.5 ± 0.3	7.5 ± 0.4	8.0 ± 0.3
Colour	8.2 ± 0.4	7.8 ± 0.3	8.1 ± 0.4
Texture	7.8 ± 0.5	6.8 ± 0.4	7.5 ± 0.5
Taste	8.0 ± 0.3	7.2 ± 0.5	7.8 ± 0.3
Flavour	7.9 ± 0.4	7.1 ± 0.4	7.7 ± 0.4
Overall acceptability	8.4 ± 0.3	7.6 ± 0.3	8.0 ± 0.3

Table 5 provides insight into the overall consumer acceptability and sensory scores for microgreens of red amaranthus, fenugreek, and spinach microgreens.

Red Amaranthus: Exhibited the highest scores in appearance (8.5 ± 0.3) and overall acceptability (8.4 ± 0.3), indicating a visually appealing and well-accepted product. The colour (8.2 ± 0.4) and taste (8.0 ± 0.3) were also rated high, suggesting a favorable combination of sensory attributes.

Fenugreek: Scored lower across most sensory attributes compared to red amaranthus and spinach. The texture (6.8 ± 0.4) and flavour (7.1 ± 0.4) were less preferred, which might indicate a stronger or more distinct taste that not all consumers enjoy. Overall acceptability (7.6 ± 0.3) was lower but still within an acceptable ranged.

Spinach: Achieved a balanced sensory profile with high scores in appearance (8.0 ± 0.3) and colour (8.1 ± 0.4). The taste (7.8 ± 0.3) and overall acceptability (8.0 ± 0.3) were also well-received, indicating a generally favorable consumer perception.

Michell *et al.* (2020) conducted a study to know consumer acceptance and intensity of sensory attributes among males and women for arugula, broccoli, bull's blood beet, red cabbage, red garnet amaranth, and tendril pea microgreens and the result showed that females generally rate the appearance and texture of microgreens, such as arugula and broccoli, more favorably compared to males. For instance, females rated the appearance of arugula higher (mean: 8.4) than males (mean: 7.5), and texture higher as well (female

mean: 8.1, male mean: 7.2). Similarly, females perceived arugula to had a higher heat intensity (mean: 7.2) compared to males (mean: 6.5). Additionally, females rated the appearance of broccoli microgreens (mean: 8.4) higher than males (mean: 7.7).

The studies also showed that overall acceptability ratings for bull's blood beet and red garnet amaranth microgreens were more favorable among females (means: 7.3 and 7.6, respectively) compared to males (means: 6.2 and 6.8, respectively) These findings were on par with the present study.

This sensory analysis highlighted the varying consumer preferences for different microgreens and underscored the importance of considering multiple sensory attributes to gauge overall acceptability.

Conclusion:

This study clearly shows that adding vermicompost to cocopeat makes a big difference in how well microgreens grow, including Red Amaranthus, Fenugreek and Spinach. The microgreens grown in the cocopeat-vermicompost mix had better growth and higher yields, both fresh and dried, compared to those grown in just cocopeat. Sensory evaluations revealed that these microgreens had varied but generally favorable flavor profiles, with Red Amaranthus being particularly well-liked and Spinach having a mild taste that many people enjoy.

These results highlight the benefits of using a cocopeat-vermicompost mixture as an optimal growing medium, supporting sustainable and efficient production of microgreens.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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