GROWTH OF CABBAGE (*Brassica oleraceae* capitata group) MICROGREENS AS AFFECTED BY THREE SUBSTRATES

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Three substrates (cocopeat, carbonized rice hull, and vermiculite) were used to determine their effects on cabbage microgreens under ambient conditions (30 ± 2 ˚C and 60 ± 5% relative humidity). The experiment was laid out in a Completely Randomized Design and replicated four times. All the microgreens in all substrates were harvested 10 days after emergence (DAE). Based on the results, the growth (seedling height, hypocotyl length, fresh weight, and root length) and yield of the microgreens grown in three substrates showed a significant difference. CRH displayed taller microgreens and longer hypocotyls than cocopeat and vermiculite. However, cocopeat produced a higher fresh weight at 5 DAE, but it was comparable with other substrates at 10 DAE. Root length in vermiculite exhibited the longest roots despite having the shortest microgreen stature and hypocotyls. However, CRH produced the highest yield, followed by vermiculite and cocopeat. Enthusiasts can use the CRH as an alternative substrate for cabbage microgreens due to its taller stature of microgreens, long hypocotyl, and high yield. Thus, cabbage microgreens grown in CRH are promising as a source of functional food and additional livelihood.

Keywords: carbonized rice hull, CRH, short duration harvesting, tiny food plants

INTRODUCTION

Microgreens are tender, immature seedlings in which the true leaves have emerged. Harvesting can be done approximately 7-21 days after sowing, depending on the crop species (Partap et al., 2023). Some of the crops that can be used as microgreens are Brassicaceae (cabbage, purple radish, and cauliflower), roselle, morning glory, Fabaceae (green pea and mungbean) (Kowitchroen et al., 2021), and herbs and spices (Gunjal et al., 2024). There is an increasing demand for microgreens due to their health benefits because of the antioxidants. Some studies reported that it contains high amounts of phenolic, ascorbic acid, tocopherols, anthocyanin, and carotenoids, making the microgreens popular (Kowitcharoen et al., 2021; Xiao et al., 2016). Moreover, it was reported that these compounds were higher than the mature ones (Kyriacou et al., 2016).

The cultivation of microgreens can be done outdoors or indoors, given that the substrates to be used are considered, which is one of the essential factors for microgreens; thus, a controlled environment can be created (Zhang et al., 2021). Therefore, even during the rainy season, the cultivation can be done anytime, especially if the needed inputs are locally available, and thus, the supply of microgreens would not be a problem due to a sustainable supply year-round. On the other hand, substrates are one essential input in growing microgreens, especially since the available varieties may not be the same as the previous studies outside the country, which may have different responses. Bulgari et al. (2021) reported that using vermiculite resulted in higher anthocyanin, whereas using coconut fiber resulted in higher anthocyanin levels in green basil. Additionally, rocket microgreens were better to grow in coconut fiber than vermiculite and fiber due to the high contents of carotenoids. In terms of the growth performance of microgreens using substrates, the combination of cocopeat + vermiculite + perlite showed greater root and shoot lengths, leaf length, and weight of 100 microgreens, and yield than vermicompost alone (Pathania et al., 2022). In another study, soil with cow dung displayed high fresh and dry weights in mustard, leaf mustard, radish, and cabbage (Polash et al., 2019). Due to its different effects on the crop species as microgreens and the limited use of carbonized rice hull (CRH) as a substrate for microgreen production is observed. CRH contains phosphorus, potassium, calcium, and magnesium (Philippine Rice Research Institute, 2019). A previous report that CRH provided better growth of cauliflower microgreens (Rabago et al., 2024). Therefore, the utilization of CRH for cabbage microgreens is a promising substrate, especially since the cultivation of these tiny plants is still limited in the Philippines. Thus, the study was conducted to determine the growth and yield of cabbage as microgreens grown in three substrates under ambient conditions.

MATERIALS AND METHODS

Green Acre variety was used as microgreens and the seeds were purchased online. The seeds were sterilized with commercial sodium hypochlorite for 30 min, then air drying was done after seed sterilization and washing with distilled water three times. Microgreen trays (32cm x 24cm x 45cm) were used to sow the air-dried seeds using three substrates (cocopeat, CRH, and vermiculite). The substrates were purchased from a Flower Shop in the locality. Microgreens were grown in ambient conditions (30 ± 2 ˚C and 60 ± 5% relative humidity). Distilled water was used to irrigate the microgreens by spraying. Daily irrigation was done to ensure that the microgreens had enough water during their growth. No supplemental fertilizer application was done. The microgreens were exposed to white light between 6 and 8 hours from 5 days after emergence (DAE) and lasted until 10 DAE.

The seedling height, hypocotyl length, root length, fresh and dry weight, and yield were gathered. Moreover, a refractometer was used to record the total soluble solids (TSS) of the microgreens. A sterilized scissor was used to harvest the microgreens and harvesting was done at 10 DAE.

Seedling height and hypocotyl length

A ruler was used to measure the seedling height and hypocotyl length from the above substrate up to the tip of the leaves and from the above substrate up to the point of leave attachment, respectively. Measurement was done from two days after emergence (DAE) up to eight DAE.

Root length

The root length of microgreens was measured using a ruler from the tip of the roots to the point of attachment. This was measured at harvesting.

Fresh weight and dry matter of microgreens

A digital weighing scale was used to weigh the fresh and dry weight of microgreens. The dry matter of the microgreens was measured by oven drying at 70 °C for 72 h.

Yield of microgreens

Harvesting was done using a sterilized scissor. The harvested microgreens were weighed using a digital weighing scale. The microgreens were harvested at 10 DAE, wherein the true leaves had emerged.

Statistical analysis

A Completely Randomized Design (CRD) with four replications was used in the study. One-way analysis of variance for CRD was used. The Least Significant Difference test was used to determine the means differences. STAR statistical program developed by the International Rice Research Institute was used for the data analysis.

RESULTS

Seedling height, hypocotyl length, and root length

At 4 to 8 DAE, it was consistently observed that the seedling height and hypocotyl length of cabbage microgreens in CRH had better performance than vermiculite and cocopeat (Table 1). However, CRH compared seedling height and hypocotyl length with vermiculite at 4 DAE. Likewise, vermiculite and cocopeat displayed a comparable seedling height and hypocotyl length in all observation periods.

On the other hand, the substrates affected root length (Table 2). Results showed that vermiculite had the longest roots, followed by CRH and cocopeat. Cocopeat was shorter in root length than CRH. This means that longer roots may have more access to absorb moisture during the growth of the microgreens.

Table 1. The seedling height and hypocotyl length of cabbage microgreens grown in different substrates.

Substrates	Seedling height (cm)				Hypocotyl length (cm)			
	2 DAE	4 DAE	6 DAE	8 DAE	2 DAE	4 DAE	6 DAE	8 DAE
Cocopeat	2.99 a	5.11 b	5.92 b	6.36 b	2.66 a	4.75 b	5.54 b	5.89 b
CRH	3.18 a	5.48 a	6.51 a	6.80 a	2.84 a	5.05 a	6.16 a	6.38 a
Vermiculite	2.86 a	5.28 ab	5.70 b	6.32 b	2.55 a	4.95 ab	5.25 b	5.98 b
SE	0.14	0.10	0.19	0.09	0.14	0.10	0.22	0.10

Means followed by different letters (a-b) within the column are significantly different at $p \leq 0.05$ y using Least Significant Difference (LSD) test.

DAE – days after emergence

Fresh weight, yield, dry matter, and total soluble solids of microgreens

The fresh weights of the microgreens grown in different substrates significantly differed (Table 2). CRH obtained the highest fresh weight per microgreen. However, the dry matter of microgreens grown in CRH exhibited the highest, whereas vermiculite obtained the lowest (Table 2).

A significant variation among the substrates in terms of yield was observed (Table 2). CRH displayed the highest yield, followed by vermiculite. Whereas cocopeat showed the least yield.

On the other hand, The TSS of all the substrates showed no significant difference (Table 2). This indicates that irrespective of the substrate to be used did not affect the TSS of cabbage microgreens.

Relationship of growth attributes to yield

Table 3 shows that the growth attributes exhibited a positive correlation with the yield of cabbage microgreens. A high positive correlation was observed between seedling height and hypocotyl length and yield. The other growth attributes, such as fresh weight, showed a significant positive correlation with the yield.

Table 2. The root length, fresh weight, yield, and total soluble solids of cabbage microgreens grown in different substrates.

Substrates	Root length (cm)	Fresh weight per microgreen (g)	Dry matter (%)	Yield (kg/m^2)	Total soluble solids (˚Brix)
Cocopeat	1.74 c	0.39 b	12.26 b	0.59 c	1.40 a
CRH	3.40 b	0.42 a	16.10 a	0.78 a	1.62 a
Vermiculite	4.19 a	0.39 b	8.26 c	0.65 b	1.54 a
SE	0.31	0.00	1.14	0.02	0.16

Means followed by different letters (a-c) within the column are significantly different at $p \leq 0.05$ using Least Significant Difference (LSD) test.
DAE – days after emergence

Table 3. Pearson correlation of growth attributes with the yield of cabbage microgreens.

	SH2	HL2	SH3	HL3	SH4	HL4	FW
Yield	0.68**	0.55	0.69**	0.66*	0.84**	0.87**	0.69**

** - significant at 1% level; * - significant t 5% level.
SH2 – seedling height at 4 DAE; HL2 – hypocotyl length at 4 DAE; SH3 – seedling height at 6 DAE; HL3 – hypocotyl length at 6 DAE; SH4 – seedling height at 8 DAE; hypocotyl length at 8 DAE; FW1 – fresh weight at 5 DAE; FW – fresh weight at 10 DAE.

DISCUSSION

Microgreens are promising functional foods, especially for consumers who are health-conscious about the foods they consume. The cultivation of cabbage microgreens was successful using different substrates, but it showed significant variations in growth and yield. The growth of microgreens in CRH consistently produced a higher seedling height, except at 2 and 4 DAE. However, the seedling height of CRH was higher than that of cocopeat. The result indicates that taller microgreens had a higher yield which showed a positive relationship, as reflected in Table 3. Thus, more microgreens to harvest and be eaten.

It was reported that cocopeat contains potassium, phosphorus, calcium, magnesium, and sodium (Kurniawan et al., 2018; Fami, 2013) that can be used for the growth of microgreens. While previous study reported the physical and chemical characteristics of vermiculite wherein their values are within the range suitable for cultivation (Wieth et al., 2021). However, microgreens grown in cocopeat had the shortest root length (Table 2) may be due to its physical characteristics, wherein this substrate has a high water holding capacity resulting in low aeration, hence affecting the oxygen diffusion to the roots (Awang et al., 2009). However, microgreens grown in vermiculite had the longest roots followed by CRH. The characteristics of vermiculite may contribute to the longer root length in cabbage microgreens. Despite the longer roots of vermiculite, it had a comparable fresh weight but did not outrank the yield of CRH. CRH exhibited a higher yield and outyielded the two substrates, whereas cocopeat displayed the lowest yield (Table 2). The high yield of microgreens in CRH was due to the positive correlation with the growth attributes such as seedling height and hypocotyl length, wherein CRH showed a greater attribute than the other substrates (Table 3). This indicates that CRH is a promising substrate for cabbage microgreen, which is locally available. Thus, who venture into microgreen production, the use of CRH is recommended, especially for cabbage microgreen. It was reported that CRH displayed better growth and a high yield was obtained (Rabago et al., 2024). However, cocopeat can also be used because this is also locally available, but the yield was lower than CRH. Despite the low yield of cocopeat in the study, a previous study reported that cocopeat increased the growth and yield in selected microgreens (Gunjal et al., 2024). Results showed that the dry matter of microgreens grown in CRH displayed the highest. Whereas the lowest was observed in vermiculite. Dry matter is the composition of all compounds, excluding the moisture after drying (, this indicates that microgreens in CRH may be composed of high compounds such as organic acids, sugars, and antioxidants as compared to other substrates. However, a future investigation is recommended.

However, the TSS of the substrates was comparable to each other, this means that irrespective of the substrate to be used did not affect the TSS. This result was concurred by the previous report that irrespective of the substrate, the TSS was similar (Rabago et al., 2024; Fermin et al., 2025). This was concurred with the previous study. TSS represents the sugars, acids, and phenolic compounds that are present in plant samples, which are used to determine the sweetness of a product (Lerner et al., 2024). TSS is considered to affect sensory attributes such as aroma and flavor (Sobreira et al., 2010; Macie et al., 2015), thus it is essential to consider. The identification of the bioactive compounds of the microgreens grown in three substrates is recommended for future investigations.

CONCLUSION

With only 10 DAE, the cabbage microgreens harvesting can be done. A substrate with good growth and a high yield is essential; hence, the study was conducted. CRH showed a greater impact on the growth and yield of cabbage microgreens. Likewise, CRH provided higher seedling height and hypocotyl length, and yield than the other substrates. CRH is recommended as a substrate for this variety of cabbage as microgreens. Cabbage microgreens are promising as a functional food and may serve as an additional source of income by growing them in CRH.

Further investigation of the bioactive compounds using the nutritive solution and maturity to determine the suitable concentration and peak of the compounds using the same substrates is recommended. The utilization of light-emitting diodes is one of the authors' future studies.

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