Available online at http://bjas.bajas.edu.iq
https://doi.org/10.37077/25200860.2024.37.2.21
College of Agriculture, University of Basrah

Basrah Journal of Agricultural Sciences

ISSN 1814 – 5868 Basrah J. Agric. Sci., 37(2), 276-287, 2024 E-ISSN: 2520-0860

Utilization of Locally Available Substrates And Their Effect on the Growth And Yield of Cauliflower (*Brassica oleracea botrytis* group) Microgreens

Aeron H. R. Rabago, Raymund J. G. Rosales*, Micah B. Gregorio-Balbas & Aira L. I. Pungtilan

Department of Agricultural Sciences, College of Agriculture, Food and Sustainable Development, Mariano Marcos State University, City of Batac, Ilocos Norte, Philippines

***Corresponding author email**: **R.J.G.R.**: rgrosales@mmsu.edu.ph; **A.H.R.R.**: aeronheidelbergrbg@gmail.com; **M.B.G.B.**: msgregorio@mmsu.edu.ph; **A.L.I.P.**: aipungtilan@mmsu.edu.ph

Received 23th July 2024; Accepted 8th December 2024; Available online 31st December 2024

Abstract: The present study was conducted to investigate the effects of substrates on the growth and production of cauliflower microgreens (*Brassica oleracea* botrytis group), Two varieties (Makita and Moonlight) were grown in different substrates consisting of cocopeat, carbonized rice hull (CRH), perlite with cocopeat (equal parts) and vermiculite and were harvested 6 days after emergence. The study was conducted under ambient conditions (temperature: 28 ± 2 °C and relative humidity: 65 ± 5%) for 8 days of cultivation from sowing. The results showed that the types of substrates significantly affect the growth and production of cauliflower microgreens. Based on the effects of substrates on each variety, for the Makita variety, perlite with cocopeat showed longer roots and similar fresh weight compared to CRH. While Moonlight variety showed taller microgreens, longer hypocotyls, and longer leaves when grown in perlite with cocopeat medium compared to other substrates. Moreover, the fresh weight of microgreens grown in perlite with cocopeat was higher compared to cocopeat and CRH, Perlite with cocopeat and cocopeat showed higher yields which were similarly higher than vermiculite and CRH. Substrates did not record a significant effect on total soluble solids for both varieties, On the other hand, Moonlight yields outperformed Makita yields, especially in perlite with cocopeat substrate which also recorded better growth for Moonlight Hence for high-yielding microgreens.

Keywords: Cauliflower microgreen, Functional food, Growing media, Short growing period, Tiny food.

Introduction

The cultivation of microgreens is increasing due to its simple and easy management, it requires a small space, which can be indoor or outdoor, and the inputs are manageable. Microgreens are small tender edible plants that can be harvested when true leaves have emerged or have not yet emerged, depending on the crop species (Bulgari *et al.*, 2017; Eswaranpillai *et al.*, 2023). The increment of demand for microgreens due to their nutritional composition and antioxidants (ascorbic acid, phenolic contents, flavonoids, and carotenoids), which are required for human consumption, especially for health-conscious people (Yadav *et al.*, 2019; Bhaswant *et al.*, 2023; Paglialunga *et al.*, 2023). Microgreen production can be one of the components of urban farming and a good source of livelihood (Zhang *et al.*, 2021). In addition, herbs and vegetables might be good microgreen sources, including cauliflower (*Brassica oleracea* group *botrytis*) (Singh *et al.*, 2019; Bhaswant *et al.*, 2023). The microgreen production could be useful and support the sustainable food supply throughout the year.

Substrates, nutrient solution, light intensity, and crop species/variety are some factors that affect the growth, yield, and phytochemicals of microgreens. It was reported that microgreens have higher nutrients than the mature counterparts of the same variety or crop species (Xiao *et al.*, 2012; Weber, 2016), although the study was concentrated on two varieties of cauliflower, thus the mature counterpart was not included. However, the current study concentrated on the effect of substrates on two varieties of cauliflower that are available in the local market. Different substrates are available for microgreen production with different effects. Moreover, locally available substrates such as carbonized rice hull (CRH) and cocopeat can be used in microgreen production. Likewise, vermiculite and perlite are commercially available, and can also be used for microgreens. The composition, features, and capacity of these substrate types vary from one to another. The use of cocopeat and CRH may aid the burden of the growers in looking for other substrates because they are locally available. It was reported that the water retention of cocopeat was 21.03% and CRH was 9.92% (w/w) (Alam *et al.*, 2020). Although CRH substrates have a low water retention and high drainage capacity, they exhibited a higher yield of cultivated plants due to containing micronutrients such as phosphorus, potassium, calcium, and magnesium), which are essential for crop growth (PhilRice, 2019). Whereas cocopeat contains potassium, phosphorus, calcium, magnesium, and sodium, depending on the source (Kurniawan *et al.*, 2018; Gbollie *et al.*, 2021). Substrates may contain different water-holding capacity may be due to their total porosity and pore types (Bunt, 1988). Moreover, water retention depends on the processing and handling techniques (Awang *et al.*, 2009). Therefore, aside from cocopeat, CRH is a promising substrate for microgreen growth. CRH was originally used for media mixture for ornamental plants but lacking in microgreens.

Due to the lack of studies that investigate the effect of CRH on microgreen growth compared to other substrates, this study was conducted to determine the effect of CRH and other substrates on the growth and yield of two varieties of cauliflower as microgreens.

Materials & Methods

Seed Preparation and Sowing

Two commercially available cauliflower varieties (Moonlight and Makita) were used as microgreens. The Moonlight and Makita variety has 55 and 45 days of maturity, respectively. The seeds were separately soaked in distilled water for 6 h and at the 5^{th} hour and 30 min, the water was mixed with commercial sodium hypochlorite and soaked for 30 min (Kowitcharoen et al., 2021). After which, the seeds were rinsed with distilled water three times and air dried before sowing in microgreen trays (32cm x 24cm x 4.5cm). CRH and cocopeat were purchased in a private shop in the locality, while the perlite and vermiculite were purchased online.

Microgreens growth and harvesting

Sown seeds were exposed to dark conditions in an ambient condition (temperature: 28 ± 2˚C; relative humidity: 65 ± 5%) until 3-4 cm of hypocotyl were evident. An indoor experiment was done to grow the microgreens. The microgreens were exposed to 6-8 h with light (white fluorescent lamp) and darkness afterward. The microgreens were irrigated with distilled water two times every irrigation, which was done every day. No supplemental nutrient application was done for the two varieties of cauliflower microgreens. Microgreens were harvested at 6 DAE, and harvesting was done by cutting the microgreens from above the surface of the substrate using a sterilized scissor.

Microgreen height, hypocotyl length, and leaf length

The microgreen height was measured from the substrate surface up to the leaf tip using a ruler. Hypocotyl length, however, was measured from the substrate surface up to the point of attachment of the leaf using a ruler. For the leaf length, this was gathered by getting the difference between microgreen height and leaf length. These parameters were gathered for six days from emergence with a 2-day interval.

Root Length

At six DAE, the root length of the microgreens was measured using a ruler.

Fresh and Dry Weights, and Fresh Weight of 100 Microgreens

The fresh and dry weights of 50 microgreens were measured by weighing in a digital weighing scale before and after oven drying (105°C until the weight was stable). The average weights of the 50 microgreens were used to get the individual weight. However, the fresh weight of 100 microgreens was weighed in a digital weighing scale.

Yield and Biomass

The yield of microgreens was recorded by harvesting grown in each tray and converted into kg per m^2. The weights were recorded using a digital weighing scale. The biomass of the microgreens was measured by oven drying at 70°C for 72 h (AOAC, 2000).

Moisture Content and Total Soluble Solids

Fifty microgreen samples were used to measure the moisture content by oven drying at 105°C until the weight was stable. The total soluble solids (TSS) of the microgreens were measured at 6 DAE using a digital refractometer.

Statistical Analysis

The substrates and varieties were arranged in a Completely Randomized Design with four replications. An SPSS program (SPSS for Windows Version 17.0 Released 2008, SPSS Inc., Chicago, Illinois, USA) was used to analyze the data. The means and standard errors were used to present the data, and the means were compared using a Least Significant Difference test for the substrates, while an independent *t*-test was used for the difference between the two varieties.

Results & Discussion

Microgreen Height

The microgreen height of the cauliflower microgreens was significantly affected by substrates and a significant variation between varieties was observed (Table 1). It was evident that the seedling height of the microgreens increased gradually as the plants grew older from 2 to 6 DAE. For the Makita variety, the microgreen height was taller if grown in a combination of perlite + cocopeat at 2 DAE, but at 6 DAE, the height of Makita microgreens was taller with CRH substrate. However, for the Moonlight variety, the seedling height was the opposite of the Makita variety. At 6 DAE, vermiculite produced the shortest stature, which was observed in both varieties. In terms of the difference between the two varieties, Makita was taller than Moonlight if grown in CRH and vermiculite. Whereas a combination of perlite + cocopeat displayed taller microgreens of Moonlight than Makita.

Table (1): The microgreen height of two varieties of cauliflower as microgreens as affected by substrates at different period.

Substrate	Microgreen height (cm)					
	2 DAE		4 DAE		6 DAE	
	V1	V2	V1	V2	V1	V2
Cocopeat	4.52 ± 0.02 cA	4.37 ± 0.17 abA	6.92 ± 0.02 bB	7.62 ± 0.09 aA	9.67 ± 0.04 cA	9.44 ± 0.03 bA
CRH	4.77 ± 0.03 bA	4.55 ± 0.08 aA	9.21 ± 0.03 aA	7.56 ± 0.20 aB	11.85 ± 0.02 aA	9.55 ± 0.07 bB
P+C	4.86 ± 0.02 aA	4.11 ± 0.15 bB	6.86 ± 0.03 bB	7.33 ± 0.22 aA	9.80 ± 0.03 bB	10.10 ± 0.05 aA
Vermiculite	2.96 ± 0.01 dB	3.29 ± 0.16 cA	5.32 ± 0.02 cA	4.88 ± 0.07 bB	6.27 ± 0.02 dA	5.89 ± 0.04 cB
SE	0.04	0.20	0.04	0.23	0.04	0.07

V1 – Makita; V2- Moonlight; P+C – perlite and cocopeat
Values are the means ± standard error. Means with different lowercase ($^{a\text{-}d}$) in a column and uppercase letters ($^{A\text{-}B}$) in a row are significantly different at $P \leq 0.05$ by using Least Significant Difference (LSD) test and *t*-test, respectively.

Hypocotyl Length

Table (2) shows the significant impact of substrates and varieties of cauliflower microgreens growth. The same trend as the seedling height was observed in the hypocotyl length of the microgreens, except for the difference between varieties. Makita displayed longer hypocotyl than Moonlight if they were grown in cocopeat and CRH. Makita and Moonlight had the same hypocotyl length if grown in perlite + cocopeat and vermiculite.

Table (2): The hypocotyl length of microgreens of cauliflower of two varieties of cauliflower as microgreens as affected by substrates at different period.

Substrate	Hypocotyl length (cm)					
	2 DAE		4 DAE		6 DAE	
	V1	V2	V1	V2	V1	V2
Cocopeat	4.06 ± 0.02 cA	3.91 ± 0.17 abB	6.38 ± 0.02 bA	7.07 ± 0.09 aB	9.02 ± 0.04 cA	8.79 ± 0.03 bB
CRH	4.32 ± 0.03 bA	4.10 ± 0.10 aA	8.65 ± 0.04 aA	7.02 ± 0.20 aB	11.21 ± 0.02 aA	8.90 ± 0.07 bB
P+C	4.42 ± 0.03 aA	3.65 ± 0.14 bB	6.31 ± 0.04 bA	6.77 ± 0.22 aA	9.14 ± 0.03 bA	9.46 ± 0.05 aA
Vermiculite	2.52 ± 0.01 dA	2.87 ± 0.16 cA	4.76 ± 0.02 cA	4.42 ± 0.07 bA	5.72 ± 0.02 dA	5.44 ± 0.04 cA
SE	0.03	0.20	0.04	0.23	0.04	0.07

V1 – Makita; V2- Moonlight; P+C – perlite and cocopeat
Values are the means ± standard error. Means with different lowercase ($^{a\text{-}d}$) in a column and uppercase letters ($^{A\text{-}B}$) in a row are significantly different at $P \leq 0.05$ by using Least Significant Difference (LSD) test and *t*-test, respectively.

Leaf Length

The leaf length of microgreens of two varieties of cauliflower that were grown in different substrates showed significant differences at 4 and 6 DAE (Table 3). At 4 DAE, a longer leaf length of Moonlight was observed in perlite + cocopeat compared to other substrates, wherein they produced similar leaf lengths. However, in terms of the difference between the varieties, Makita grown in vermiculite produced longer leaves compared to Moonlight. However, at 6 DAE, grown plants in perlite + cocopeat displayed longer leaves than CRH-plants and vermiculite-plants for the Makita variety. Cocopeat-plants had a similar leaf length to perlite + cocopeat and CRH-plants. While Moonlight grown in vermiculite had the shortest leaves compared to other substrate plants. Makita showed a longer leaf than Makita if grown in vermiculite. There was no significant difference observed between both verities in the leaf length feature of microgreens that grown in all the substrates.

Table (3): The leaf length of two varieties of cauliflower as microgreens as affected by substrates at different period.

Substrate	Leaf length (cm)					
	2 DAE		4 DAE		6 DAE	
	V1	V2	V1	V2	V1	V2
Cocopeat	0.45 ± 0.00 aA	0.46 ± 0.02 aA	0.55 ± 0.00 aA	0.54 ± 0.01 bA	0.65 ± 0.00 abA	0.66 ± 0.01 aA
CRH	0.46 ± 0.01 aA	0.46 ± 0.01 aA	0.56 ± 0.01 aA	0.55 ± 0.00 bA	0.64 ± 0.00 bA	0.64 ± 0.01 aA
P+C	0.45 ± 0.01 aA	0.46 ± 0.02 aA	0.55 ± 0.01 aA	0.56 ± 0.00 aA	0.66 ± 0.01 aA	0.64 ± 0.01 aA
Vermiculite	0.45 ± 0.00 aA	0.42 ± 0.01 aA	0.56 ± 0.01 aA	0.46 ± 0.00 cB	0.56 ± 0.00 cA	0.45 ± 0.01 bB
SE	0.01	0.02	0.01	0.01	0.01	0.01

V1 – Makita; V2- Moonlight; P+C – perlite and cocopeat
Values are the means ± standard error. Means with different lowercase ($^{a-d}$) in a column and uppercase letters ($^{A-B}$) in a row are significantly different at $P \leq 0.05$ by using Least Significant Difference (LSD) test and *t*-test, respectively.

Root length

The two varieties of cauliflower microgreens grown in different substrates showed significant differences (Table 4). For Makita, the longest roots were observed in vermiculite-plants, while the shortest was observed in perlite + cocopeat-plants. However, for Moonlight, grown plants in CRH and vermiculite provided longer roots than the other substrate plants. Substrates using CRH and vermiculite produced longer roots of Makita plants compared to Moonlight. But Moonlight had longer roots compared to Makita. when using cocopeat and perlite + cocopeat substrate.

Table (4): The root length of microgreens of two cauliflower varieties as microgreens as affected by substrates.

Substrate	Root length (cm)	
	V1	V2
Cocopeat	1.27 ± 0.05 cB	1.65 ± 0.01 bA
CRH	3.18 ± 0.10 bA	2.28 ± 0.06 aB
P+C	1.21 ± 0.09 cB	1.74 ± 0.06 bA
Vermiculite	4.44 ± 0.10 aA	2.41 ± 0.11 aB
SE	0.12	0.10

V1 – Makita; V2- Moonlight; P+C – perlite and cocopeat
Values are the means ± standard error. Means with different lowercase ($^{a-d}$) in a column and uppercase letters ($^{A-B}$) in a row are significantly different at $P \leq 0.05$ by using Least Significant Difference (LSD) test and *t*-test, respectively.

Fresh and dry weights, and fresh weight of 100 microgreens

Fresh and dry weights and fresh weight of 100 plants of microgreens of two cauliflower varieties that grown in different substrates had significant variation (Table 5). For Makita, fresh weight was significantly higher in CRH and perlite + cocopeat than cocopeat and vermiculite. However, for Moonlight, grown plants in vermiculite had the lowest fresh weight than the other grown plants in other substrates. For both verities that grown in CRH and perlite + cocopeat, Makita exceeds on Moonlight in the fresh weight trait. Whereas both varieties displayed similar fresh weights when grown in cocopeat and vermiculite substrates. On the other hand, the dry weight was higher of grown plants in perlite + cocopeat than cocopeat and vermiculite, but it was similar to CRH for the Makita. For Moonlight, grown plants in cocopeat and CRH had higher dry weights at the beginning and the latter showed similarities to grown plants in other substrates. For the fresh weight of 100 plants of microgreens, Makita recorded higher 100 plants fresh weight when grown in CRH and perlite + cocopeat. However, the two varieties did not show a significant difference when grown in cocopeat and vermiculite substrates.

Table (5): The fresh and dry weights, and fresh weight of 100 microgreen plants of two cauliflower varieties as affected by substrates.

Substrate	Fresh weight (g/plant)		Dry weight (g/plant)		Fresh weight of 100 plants (g)	
	V1	V2	V1	V2	V1	V2
Cocopeat	0.0537 ± 0.00 bA	0.0570 ± 0.00 aA	0.0026 ± 0.00 bA	0.0027 ± 0.00 aA	5.38 ± 0.025 bA	5.70 ± 0.12 aA
CRH	0.0665 ± 0.00 aA	0.0568 ± 0.00 aB	0.0027 ± 0.00 abA	0.0026 ± 0.00 abA	6.65 ± 0.25 aA	5.68 ± 0.11 aB
P+C	0.0607 ± 0.00 aA	0.0570 ± 0.00 aB	0.0028 ± 0.00 aA	0.0024 ± 0.00 bA	6.08 ± 0.09 aA	5.70 ± 0.11 aB
Vermiculite	0.0478 ± 0.00 cA	0.0452 ± 0.00 bA	0.0025 ± 0.00 cA	0.0024 ± 0.00 bA	4.78 ± 0.13 cA	4.53 ± 0.06 bA
SE	0.00	0.00	0.00	0.00	0.27	0.15

V1 – Makita; V2- Moonlight; P+C – perlite and cocopeat
Values are the means ± standard error. Means with different lowercase ($^{a-d}$) in a column and uppercase letters ($^{A-B}$) in a row are significantly different at $P \leq 0.05$ by using Least Significant Difference (LSD) test and *t*-test, respectively.

Yield and biomass

Microgreens in CRH outyielded the grown plants in the other substrates for Makita (Table 6). Whereas for Moonlight, grown plants in perlite + cocopeat outyielded CRH-plants and vermiculite-plants, which gave a similar yield compared to cocopeat. Moonlight had a higher yield compared to Makita irrespective of the used substrates. Biomass in Makita was higher if the substrates used were cocopeat and vermiculite (Table 6).

Table (6): The yield and biomass of microgreens of two cauliflower varieties as affected by substrates.

++Substrate	Yield (kg/m^2)		Biomass (%)	
	V1	V2	V1	V2
Cocopeat	0.60 ± 0.04 cB	1.85 ± 0.07 abA	4.97 ± 0.22 aA	4.77 ± 0.13 bA
CRH	1.26 ± 0.06 aB	1.72 ± 0.12 bA	4.13 ± 0.09 cA	4.57 ± 0.20 bcA
P+C	0.92 ± 0.07 bB	2.01 ± 0.03 aA	4.52 ± 0.04 bA	4.17 ± 0.20 cA
Vermiculite	0.81 ± 0.02 bB	1.06 ± 0.02 cA	5.25 ± 0.08 aA	5.40 ± 0.06 aA
SE	0.07	0.10	0.18	0.22

V1 – Makita; V2- Moonlight; P+C – perlite and cocopeat
Values are the means ± standard error. Means with different lowercase ($^{a-d}$) in a column and uppercase letters ($^{A-B}$) in a row are significantly different at $P \leq 0.05$ by using Least Significant Difference (LSD) test and *t*-test, respectively.

For Moonlight, grown plants in vermiculite displayed the highest biomass compared to other substrate plants. The biomass of the two varieties exhibited no significant difference irrespective of the substrates.

Moisture content and total soluble solids

The moisture content and TSS of cauliflower microgreens were significantly affected by substrates and varieties (Table 7). Grown plants in CRH displayed the highest moisture content among the substrates for Makita. While for Moonlight, grown plants in perlite + cocopeat and CRH showed the highest moisture content. Two varieties exhibited no significant difference when they were grown in different substrates. Likewise, total soluble solids were not affected remarkably by substrates, and the varieties.

Table (7): The moisture content and total soluble solids of two cauliflower varieties as affected by substrates.

Substrate	Moisture content (%)		Total soluble solids (% Brix)	
	V1	V2	V1	V2
Cocopeat	95.03 ± 0.22 cA	95.23 ± bA	1.94 ± 0.11 aA	1.96 ± aA
CRH	95.87 ± 0.09 aA	95.43 ± abA	1.92 ± 0.04 aA	2.08 ± aA
P+C	95.48 ± 0.04 bA	95.83 ± aA	1.92 ± 0.02 aA	2.03 ± aA
Vermiculite	94.75 ± 0.08 cA	94.59 ± cA	1.82 ± 0.04 aA	1.83 ± aA
SE	0.18	0.22	0.09	0.13

V1 – Makita; V2- Moonlight
Values are the means ± standard error. Means with different lowercase ($^{a-d}$) in a column and uppercase letters ($^{A-B}$) in a row are significantly different at $P \leq 0.05$ by using Least Significant Difference (LSD) test and *t*-test, respectively.

Discussion

Our study showed that cauliflower microgreens grown in vermiculite substrate displayed the shortest stature and hypocotyl in all observation periods, which was observed in two varieties (Tables 1 and 2). The growth, specifically in microgreen height was faster in perlite + cocopeat, which was observed in Makita and Moonlight. Despite Makita plants in perlite + cocopeat having fast growth, it did not exceed significantly the grown microgreens in CRH, which had the highest height microgreens (Table 1). Whereas for Moonlight, grown plants in perlite + cocopeat exhibited significant height microgreens compared to other substrates-plants. The microgreen height of Makita and Moonlight that are grown in vermiculite was almost half of the plant height of CRH and perlite + cocopeat substrates, respectively. However, in terms of the comparison between the two varieties, Makita-grown plants in CRH and vermiculite displayed the highest height microgreens compared to Moonlight. Perlite + cocopeat obtained remarkable height microgreens in Moonlight compared to Makita. Results indicate that significant height microgreens would have a good yield to obtain. Vermiculite produced short stature and hypocotyls in both varieties as microgreens may be due to its feature that has a high-water holding capacity, which will reduce the growth of plants due to limited oxygen concentration that will also limit the absorption of moisture (Indrasumunar & Gresshoff, 2013). Some of the metabolic processes that require oxygen are carbohydrate metabolism and absorption of nutrients by the roots (Roblero *et al*., 2020). Likewise, if there is a limited oxygen supply in the roots these metabolic processes are affected which will lead to stunted growth. This signifies that vermiculite must be mixed with other substrates that improve its aeration. Therefore, a future study on the mixture of vermiculite with other substrates using the same cauliflower varieties will be explored.

The differences in the growth concurred with the previous study that there are variations of the microgreen varieties in their growth if grown in different substrates (Pathania *et al*., 2022). Previous studies reported also that growth was due to genetic variations among cultivars (Khudur *et al*., 2019; Al-Hasany *et al*., 2019; Al-Furtuse *et al*., 2019). Variation effects by substrates were also reported by previous studies (Bulgari *et al*., 2021; Saleh *et al*., 2022). This proves that the growth of microgreens diverges due to varietal and substrate variation. However, there was no significant impact on the total soluble solids of the microgreens.

At 6 DAE, CRH-plants demonstrated a longer hypocotyl in Makita and almost twice the hypocotyl length of vermiculite-plants, which had the shortest hypocotyl as compared to other substrates. The Moonlight microgreens had longer hypocotyls if grown in perlite + cocopeat. Makita microgreens had longer hypocotyls than Moonlight if they were grown in cocopeat and CRH. Additionally, while, Makita and Moonlight were grown in perlite + cocopeat and vermiculite showed no significant variation. This indicates that irrespective of the used substrate either perlite + cocopeat or vermiculite, plants of Makita and Moonlight had the same hypocotyl length. It implies that these substrates support the needed growth of the two cauliflower varieties. Likewise, in the case of CRH and cocopeat, results indicate that each variety was affected by the used substrates. The root length of microgreens could be affected by the shoot system growth by the absorption of moisture from the substrate. The importance of roots was also reported about their role in abiotic and favorable conditions (Qadir, 2019). However, it does not indicate that having longer roots would have taller and longer stature and hypocotyl, respectively (Table 4). It was revealed that vermiculite-plants have longer roots in both varieties. Results revealed that substrates significantly impact the growth of microgreens with several variations observed between the two varieties, as concurs with the other studies (Bulgari *et al*., 2021; Saleh *et al*., 2022). The different substrates have different water retention capacities that affect the availability of moisture to be absorbed by the roots of microgreens.

The fresh weight of every microgreen and the fresh weight of 100 plants of Makita microgreens were higher when using CRH and perlite + cocopeat substrates, while two vegetative features were significant of Moonlight plants in the same substrates and cocopeat (Table 5). CRH and perlite + cocopeat provided higher fresh weights in

Makita compared to Moonlight. Whereas Makita and Moonlight displayed similarities when they were grown in cocopeat and vermiculite. On the other hand, the moisture content of microgreens, particularly in Makita, was higher in CRH plants followed by perlite + cocopeat. These substrates were provided a high moisture content for Moonlight microgreens (Table 6). The moisture contents of both varieties of cauliflower microgreens were similar irrespective of the substrates. The moisture may have an impact on the yield of microgreens, it was observed that the yield of Makita grown in CRH obtained the highest moisture content among the other substrates-plants. But in the case of Moonlight, it may not be the same wherein perlite + cocopeat and cocopeat had the highest microgreen yield as compared with other substrates, wherein the former, including CRH, had the highest moisture contents. Moreover, the high yield in CRH-plants of Makita and perlite + cocopeat-plants of Moonlight may be due to high fresh weight, longer hypocotyl, and the highest height of microgreens, compared to the other substrates. This implies that the fresh weight, hypocotyl length, and stature were essential vegetative characteristics that contributed to the high yield of microgreens. Moreover, each variety of the cauliflower microgreen had different substrates needed to obtain a high yield. Additionally, the substrate for each variety is very specific. The CRH and cocopeat (present in a substrate, perlite + cocopeat) had different compositions. CRH contains phosphorus, potassium, calcium, and magnesium (PhilRice, 2019), whereas cocopeat contains potassium, phosphorus, calcium, magnesium, and sodium, depending on the source (Kurniawan *et al*., 2018; Gbollie *et al*., 2021), which may be contributed to the high yield of each cauliflower variety. However, other parameters, such as root mass, mineral contents and phytochemicals in the substrate used and microgreens, and other essential data related to the impact on growth must be considered for further investigations. However, the biomass of the two varieties of cauliflower microgreens was varied by substrates, which conforms to another study (Bulgari *et al*., 2021). The biomass of Makita microgreens was higher in cocopeat and vermiculite substrates, while in Moonlight-plants, it was higher in vermiculite substrate. However, the biomass of microgreens did not exhibit any significant differences between the two varieties. It should be noted that biomass is composed of inorganic components, cellulose, hemicellulose, lignin, and other components and these are varied among crop species (Yang & Lu, 2021). The composition of the microgreens grown in different substrates is a worthy study to explore, especially since the biomass of the two cauliflower varieties showed a significant variation among substrates.

Conclusion

The two varieties of cauliflower were successfully produced as microgreens. Makita and Moonlight varieties were affected by the substrates. CRH was a suitable substrate for Makita due to its higher stature, longer hypocotyl, and higher yield. This trend concerning the same parameters was observed in perlite + cocopeat for Moonlight. Growth parameters, such as height, hypocotyl length, and fresh weight play pivotal roles in the yield of microgreens. The enthusiasts can choose between the two varieties and the substrate to be used. But for a higher yield, Moonlight's yield outyielded Makita microgreen. CRH is recommended for Makita, while perlite + cocopeat for

Moonlight due to higher yield contributed by the mentioned growth characteristics. However, if the purchase of perlite is the concern, cocopeat could be used for Moonlight due to its comparable yield with perlite + cocopeat. It is suggested that phytochemical analysis must be done for the two varieties of microgreens grown in the same substrates.

Acknowledgements

The authors would like to thank the Mariano Marcos State University for the support of the study. Also, thanks to the reviewers and editors of the journal for the improvement and acceptance of the manuscript.

Contributions of authors

A.H. R.R. - Conceptualization, Data Curation, Methodology, Investigation. Writing – original draft and editing.

RJGR. - Conceptualization, Methodology, Investigation, Data Analysis, Writing and Editing – draft and final;

M.B.G.B. and **A.L.I.P.** – Methodology, Data Analysis, Writing and Editing – draft.

ORCID

R.J.G.R: https://orcid.org/0000-0003-0230-2507

Conflicts of interest

The authors declare that they have no conflict of interests.

References

Alam, M., Othman, N., Samsudin, S., Johari, A., Hassim, M., & Kamaruddin, M. (2020). Carbonized rice husk and cocopeat as alternative media bed for aquaponic system. *Sains Malayasiana*, *49*, 483-492. http://doi.org/10.17576/jsm-2020-4903-03

Al-Furtuse, A., Aldoghachi, K., & Jabail, W. (2019). Response of three varieties of cowpea (*Vigna sinensis* L.) to different levels of potassium fertilizer under southern region conditions of Iraq. *Basrah Journal of Agricultural Sciences, 32,* 24-34. https://doi.org/10.37077/25200860.2019.254

Al-Hasany, A., Aljaberi, M., & Alhilfi, S. (2019). Effect of spraying with seaweed extract on growth and yield of two varieties of wheat (*Triticum aestivum* L.). *Basrah Journal of Agricultural Sciences, 32,* 124-134. http://doi.org/10.37077/25200860.2019.145

Association of Official Analytical Chemists. A.O.A.C. (2000). Official methods of analysis AOAC International. 17th ed. Association of Official Analytical Chemists, Maryland, USA.

Awang, Y., Shaharom, A., Mohamad, R., & Selamat, A. (2009). Chemical and physical characteristics of cocopeat-based media mixtures and their effects on the growth and development of *Celosia cristata*. *American Journal of Agricultural and Biological Sciences, 4*, 63-71. http://doi.org/10.3844/AJAB.2009.63.71

Bhaswant, M., Shanmugam, D., Miyazawa, T., Abe, C., & Miyazawa, T. (2023). Microgreens-a comprehensive review of bioactive molecules and health benefits. *Molecules*, *28*. 867. https://doi.org/10.3390/molecules28020867

Bulgari, R., Baldi, A., Ferrante, A., & Lenzi, A. (2017). Yield and quality of basil, Swiss Chard, and rocket microgreens grown in a hydroponic system. *New Zealand Journal for Crops and Horticultural Science, 45*, 119-129. https://doi.org/10.1080/01140671.2016.1259642

Bunt, A. (1988). *Media and Mixes for Container-grown Plants*. 1st edition, Springer, London. https://doi.org/10.1007/978-94-011-7904-1

Eswaranpillai, U., Murugesan, P., & Karrupiah, P. (2023). Assess the impact of cultivation substrates for growing sprouts and microgreens of selected four legumes and two grains and evaluation of its nutritional properties. *Plant Science Today, 10*, 160-169. http://doi.org/10.14719/pst.2058

Gbollie, S., Mwonga, S., & Kibe, A. (2021). Effects of calcium nitrate levels and soaking durations on cocopeat nutrient content. *Journal of Agricultural Chemistry and Environment. 10,* 372-388. https://doi.org/10.4236/jacen.2021.103024

Indrasumunar, A., & Gresshoff, P. (2013). Vermiculite's strong buffer capacity renders it unsuitable for studies of acidity on soybean (*Glycine max* L.) nodulation and growth. *BMC Research Notes, 6*. 465. https://doi.org/10.1186%2F1756-0500-6-465

Khudur, S., Al-Edany, T., & Bnayan, L. (2019). Evaluation of some herbicide's efficacy in weed control accompanying some wheat cultivars and their effect on yield and its components. *Basrah Journal of Agricultural Sciences, 32, 140-155.* https://doi.org/10.37077/25200860.2019.264

Kowitcharoen, L., Phornvillay, S., Lekkham, P., Pongprasert, N., & Srilaong, V. (2021). Bioactive composition and nutritional profile of microgreens cultivated in Thailand. *Applied Sciences, 11,* 7981. https://doi.org/10.3390/app11177981

Kurniawan, E., Ishak, & Suryani. (2018). Utilization of cocopeat and goat of dirt in marking of solid organic fertilizer to quality macro nutrient (NPK). *IOP Conference Series: Materials and Science and Engineering, 543*. 012001. https://doi.10.1088/1757-899X/543/1/012001

Paglialunga, G., El Nakhel, C., Proietti, S., Moscatello, S., Battistelli, A., Formisano, L., Ciriello, M., Del Bianco, M., De Pascale, S., & Rouphael, Y. (2023). Substrate and fertigation management, modulate microgreens production, quality and resource efficiency. *Frontiers in Sustainable Food Systems, 7*. 1222914. https://doi.org/10.3389/fsufs.2023.1222914

Pathania, P., Katoch, V., Sandal, A., & Sharma, N. (2022). Roles of substrate media in growth and development of selected microgreens. *Biological Forum – An International Journal*, 14(3), 1357-1361. http://doi.org/10.13140/RG.2.2.32664.26881

Philippine Rice Research Institute (PhilRice) (2019). Golden Waste. Accessed at https://www.philrice.gov.ph/golden-waste/ on July 23, 2024.

Qadir, S. 2019. Wheat grains germination and seedling growth performance under drought condition. *Basrah Journal of Agricultural Sciences.*31(2), 44-52. https://doi.10.33762/bagrs.2018.160132 https://www.bjas.bajas.edu.iq/index.php/bjas/article/view/48

Roblero, M., Pineda, J., Leon, M., & Castellanos, J. (2020). Oxygen in the root zone and its effect on plants. *Revista Mexican Ciencias Agricolas, 11*, 931-43. https://doi.org/10.29312/remexca.v11i4.2128

Saleh, R., Gunupuru, L., Lada, R., Nams, V., Thomas, R., & Abbey, L. 2022. Growth and biochemical composition of microgreens grown in different formulated soilless media. *Plants, 11*, 3546. https://doi.org/10.3390/plants11243546

Singh, N., Sharma, A., Rani, S., & Chaurasia, O. (2019). Vegetable microgreens farming in high-altitude region of trans-himalayas to maintain nutritional diet of Indian troops. *Proceedings of the National Academy of Sciences, India-Section B: Biological Sciences, 90,* 1-10.

https://doi.org/10.1007/s40011-019-01147-0

Weber, C. (2016). Nutrient content of cabbage and lettuce microgreens grown on vermicompost and hydroponic growing pads. *Journal of Horticulture, 3*, 1-5.

http://doi.org/10.4172/2376-0354.1000190

Xiao, Z., Lester, G., Luo, Y. & Wang, Q. (2012). Assessment of vitamin and carotenoid concentrations of emerging food products: edible microgreens. *Journal of Agricultural and Food Chemistry, 60*, 7644-7651. https://doi.org/10.1021/jf300459b

Yadav, L., Koley, T., Tripathi, A., & Singh, S. (2019). Antioxidant potentiality and mineral content of summer season leafy greens: comparison at mature and microgreen stages using chemometric. *Agricultural Research, 8*, 165-175. https://doi.org/10.1007/s40003-018-0378-7

Yang, C., & Lu, X. (2021). *Composition of plant biomass and its impact on pretreatment. Advances in 2nd Generation of Bioethanol Production.* Pp, 71-85. In Lü, X. (Editor). *Woodhead Publishing Series in Energy*. Woodhead Publishing, 254pp.

https://doi.org/10.1016/B978-0-12-818862-0.00002-9

Zhang, Y., Xiao, Z., Ager, E., Kong, L., & Tan, L. (2021). Nutritional quality and health benefits of microgreens, a crop of modern agriculture. *Journal of Future Foods, 1*, 58-66. https://doi.org/10.1016/j.jfutfo.2021.07.001

استخدام الاوساط الحيوية المحلية وتأثيرها على نمو وإنتاج براعم القرنبيط (*Brassica oleracea* botrytis)

إيرون هيلدربيرغ راباغو وريمون جوليوس روزاليس وميخا بينيز جريجوريو بالباس وإيرا ليلك بونجيلان

قسم العلوم الزراعية، كلية الزراعة والأغذية والتنمية المستدامة، جامعة ولاية ماريانو ماركوس، مدينة باتاك، إيلوكوس نورتي، الفلبين

المستخلص: اجريت الدراسة الحالية لمعرفة تأثيرات الاوساط الحيوية على نمو وإنتاج براعم القرنبيط *Brassica oleracea* botrytis اذ تمت زراعة صنفين (Makita and Moonlight) في اوساط مختلفة تكونت من جوز الهند مع قشر الأرز المحروق(CRH) ، وبيرلايت مع جوز الهند (أجزاء متساوية) ووفيرميكولايت، وتم حصادها بعد 6 أيام من الإنبات. وقد أجريت الدراسة في ظروف خاصة (درجة الحرارة: 2 ± 28 درجة مئوية والرطوبة النسبية: 5 ± 65٪) لمدة 8 أيام من الزراعة، أظهرت النتائج أن أنواع الاوساط تؤثر بشكل كبير على نمو وإنتاج براعم القرنبيط ، بالنسبة للصنف Makita أظهر وسط البيرلايت مع جوز الهند تكون جذور أطول ووزنًا رطب متقارب بالمقارنة مع القشر الأرز المحروق CRH، بينما أظهر قشر الأرز المحروق CRH براعم أطول وساقًا أطول واعلى انتاج مقارنة بالأوساط الأخرى، في حين أظهر الصنف Moonlight براعم وساق واوراق أطول عند الزراعة في وسط البيرلايت مع جوز الهند مقارنة بالأوساط الأخرى، بالإضافة الى التفوق المعنوي للوزن الرطب للبراعم للنباتات النامية في وسط البيرلايت مع جوز الهند مقارنة مع جوز الهند وقشر الأرز المحروق (CRH) . أظهر البيرلايت مع جوز الهند افضل حاصل للبراعم والتي كانت أعلى من وسط الفيرميكوليت وقشر الأرز المحروق (CRH). لم تسجل الاوساط تأثيرًا معنويا ملحوظًا في المواد الصلبة الذائبة الكلية لكلا الصنفين، اظهرت نتائج الدراسة التفوق المعنوي لصنف Moonlight على صنف Makita، خاصة عند الزراعة في وسط البيرلايت مع جوز الهند التي سجلت نموًا أفضل لصنف Moonlight والذي انعكس على حاصل النبات وانتاج براعم عالية الانتاج.

الكلمات المفتاحية: براعم القرنبيط، اسمدة مغذية، فترة نمو قصيرة، مغذيات دقيقة، وسط زراعي