Plant Archives Vol. 23, No. 1, 2023 pp. 70-73 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2023.v23.no1.012

EVALUATION AND PRODUCTION OF INDOOR-GROWN MICROGREENS FOR TROPICAL KITCHEN GARDEN

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(Date of Receiving : 08-10-2022; Date of Acceptance : 18-12-2022)

ABSTRACT

Over the years, compelled by the growing interest of society in healthy eating, fresh, functional and nutraceutical foods are in the rise. Specialty crop growers, researchers and extension specialists are utilizing the upcoming trends and opportunities to tap niche products. Both the consumption of fresh produce as well as the availability of fresh produce is constantly changing. Microgreens, also known as vegetable confetti is gaining tremendous importance in this aspect. Being the immature shoots of several vegetables, herbs and spices, they are harvested right after the emergence of true leaves within duration of 2 weeks. They are consumed fresh as salad toppings in top-end restaurants. As the demand for these mini-leafy vegetables are in rise, suitable production aspects are required. Though several large-scale commercial production and marketing techniques have been discussed earlier, a need is created for indoor, rooftop and kitchen garden cultivation to enable these high value low volume greens be grown by the individual himself.
***Keywords* :** Microgreens, indoor cultivation, composition, production, yield.

Introduction

The goal of sustainable development is aggravated through population explosion, increased erratic weather due to climate change, high and volatile food prices, constant monetary and economic crisis which consequently inflates the population leading to hunger and malnutrition FAO (2011). Several challenges in food production require innovative approaches of which lack of soil, space, time to commit to traditional vegetable cultivation as well as high cost of production are the most important. Tropical countries like India and Africa are the most affected by malnutrition and hunger. Increasing population and food demand for this surging human race have always been on debates. With population increasing to about 9 billion by 2030, the foremost concern for researchers is to serve food on plates of billions utilizing the limited resources. Therefore, burgeoning interest in fresh and functional foods coupled with proper health and longevity compels the demand of vegetable production at micro scale for improving the nutritional aspects of diet.

Microgreens are edible cotyledons and seedlings of many vegetables, herbs and flowers used to provide a range of colors, textures and flavors to a variety of dishes Xiao *et al.* (2012); Pinto *et al.* (2015); Mir *et al.* (2017). Representing a new culinary trend, they are particularly popular with gourmet chefs around the world. They are harvested within 7-14 days after germinating depending upon different species at cotyledon stage and are consumed immature. They are larger than sprouts yet smaller than baby versions of vegetables. The functional components like antioxidants, phenolics, vitamins and minerals (Table- 1) were found to be higher in these specialty crops compared to their vegetable mature counterparts.

Besides normal nutritional values, because of their health promoting and disease preventing properties, they are highly prized and considered as functional foods. For production of mixed cropping, microgreens with similar growth rates are to be selected so that they can be harvested at once. In case of monoculture, they can be grown individually and mixed later. Some of the commonly cultivated vegetable greens include beet Murphy *et al.* (2010), cabbage, broccoli, radish Xiao *et al.* (2012), fenugreek, carrot, onion, palak, lettuce and amaranth. Several review papers being published in the past highly focuses on modulatory effects of LED lights, food safety and microbial infestation of growing media, biofortification on a larger scale commercialization which neglects the aspects of indoor or home cultivation. Studies on comparative growing of a variety of microgreens on indoor spaces are of great interest to consumers Alrifai *et al.* (2019); Lee *et al.* (2017) and Zhang *et al.* (2020). These miniature greens can be cultivated commercially as well as in indoor conditions of urban lands where land space is a major constrain. Hence, these nutrient dense foods which are obtained in a very short duration of less than a week within limited space and reduced cost of production with increased returns are gaining momentum in market as well as our daily lives.

Table 1: Characteristic features and bioactive compounds of different microgreens

Name	Colour and characteristics of seedling	Bioactive compounds
Amaranathus	Vibrant green leaves with earthy flavour	Phenolics, betalains
Carrot	Bright yellowish green leaves and stems	Phenolics, polyacetylene
Spinach	range from neutral to spicy, slightly sour or even bitter	Phenolics, polyacetylene
Beetroot	Vibrant red, slightly sweeter shoots	Phenolics, polyacetylene
Onion	Green stems on upper portion and white stem at lower part, pungent and mildly spicy	Diallyl disulphide and diallyl trisulphide
Fenugreek	Bold green leaves, light green stems, subtle bitter taste and mild spicy	Phenolics, folic acid
Cabbage	Greenish leaves, slightly sweet and juicy	Glucoisonates, phenoilcs, anthocyanins
Cauliflower	Bright green, white stems, mild peppery flavour	Glucoisonates, phenoilcs
Broccoli	Bright green leaves, slight pinkish stems, crunchy and dense	Glucoisonates, phenoilcs
Radish	Bold green leaves, white stems, peppery flavour	Glucoisonates, phenoilcs, anthocyanins

Materials and Methods

Microgreen selection and production

Ten culinary greens of different families were taken up for study (Table 2). These include amaranthus, beetroot and spinach (Amaranthaceae), carrot (Apiaceae), cabbage, broccoli, cauliflower and radish (Brassicaceae), Fenugreek (Leguminaceae) and Onion (Amaryllidiaceae). The study was conducted at indoor conditions in Pondicherry UT, India. A highly aerated and good moisture holding cocopeat substrate was used as a growing media. The experimental design adopted was Completely Randomized Block Design (CRD) replicated thrice. Plastic trays of 18 x 15 x 6 cm were taken for cultivation. The trays were filled with media to about three-fourth, seeds of 3g for all the microgreens, except amaranth, were 1g was sown densely over the trays and were covered with a thin layer of media. Later the trays were sprayed with water to enable germination. Just as the greens have attained their respective heights, they were harvested with the help of sharp scissors.

Table 2 : List of different microgreens taken for study

S. No	Name	Botanical name	Family	Type of germination
1.	Amaranathus	*Amaranthus tricolor*	Amaranthaceae	Epigeal
2.	Carrot	*Daucus carota*	Apiaceae	Epigeal
3.	Spinach	*Spinacia oleraceae*	Amaranthaceae	Epigeal
4.	Beetroot	*Beta vulgaris*	Amaranthaceae	Epigeal
5.	Onion	*Allium cepa*	Amaryllidiaceae	Epigeal
6.	Fenugreek	*Trigonella foenum-graucum*	Fabaceae	Epigeal
7.	Cabbage	*Brassica oleracea* var *capitata*	Brassicaceae	Epigeal
8.	Cauliflower	*Brassica oleracea* var *botrytis*	Brassicaceae	Epigeal
9.	Broccoli	*Brassica oleracea* var *italica*	Brassicaceae	Epigeal
10.	Radish	*Raphanus sativus*	Brassicaceae	Epigeal

Parameters recorded

Various growth and yield parameters that were observed include seed soaking, days to first germination (days), germination percentage (%), shoot length (cm), vigour index, fresh weight (g), dry weight (%) and days to harvest (days). Seed soaking was determined based on the nature of the seed. Days to first germination was recorded as the number of days required for the seeds to initiate seedling emergence. Germination percent was calculated as the number of seeds germinated to the total number of seeds sown. Shoot length was obtained by measuring the length of from the base to the tip of leaves. The multiplication of seedling height with germination percentage resulted in vigour index. Fresh weight was calculated based on the weight of seedlings in individual trays. Days to harvest were recorded as the number of days taken for microgreens to mature from the date of sowing.

Statistical analysis

The data was converted to mean values for all the microgreens and was statistically analyzed using DSAASTAT tool. For treatments showing significance, critical differences were worked out at five percent probability level.

Result and Discussion

All the greens taken up for study were exposed to seed soaking except amaranthus, broccoli, cauliflower and radish (Table 3). With respect to days to first germination, fenugreek germinated earliest at 2.08 days, followed by radish (2.16 days) and amianthus (2.51 days). The earlier emergence of fenugreek seedlings might be due to advanced seed metabolism which sped up germination when the seeds were soaked overnight Ashraf and Foolad (2005). Beetroot was the last to germinate, this might be because of the nature of beet seeds. The seedball consisting of multigerm are wrapped in a woody pericarp having impervious sclerenchyma that restricts water and oxygen uptake by the enclosed seeds Chomontowski and Podlaski (2020). Germination percentage, shoot length and vigor index were found to be maximum in radish with 98.15 %, 7.45 cm and 733.53 respectively. Onion had the least germination percent (74.21 %). Similar reports for maximum germination Ramya *et al*. (2020). Carrot had a minimum shoot length (4.26 cm) and least vigor index (382.46), which was similar to the findings of Ghoora and Srividya (2018).

For fresh weight and dry weight (Table 4), maximum fresh weight and yield per tray was recorded in radish (63.47 g/tray) with a dry weight at 4.76 %. Beetroot, contrary to this had the lowest fresh weight of 10.09 g/tray with a dry weight of 0.91%. Radish microgreens were said to have maximum number of plants per tray as well as yield per tray as reported by Ramya *et al.* (2020). Highest total fresh yield in radish was also reported by Ghoora and Srividya (2018). Dry weight was at its least in beetroot, indicating the higher moisture content of the produce. It may be concluded that high dry matter is associated with higher shelf life Manzocco *et al*. (2011).

Table 3 : Mean Performance of different microgreens for growth parameters

S. No.	Microgreen	Seed soaking	Days to first germination (days)	Germination percentage (%)
1.	Amaranathus	x	2.51	94.35
2.	Carrot	✓	5.70	89.78
3.	Spinach	✓	2.80	97.64
4.	Beetroot	✓	6.28	91.74
5.	Onion	✓	5.20	74.21
6.	Fenugreek	✓	2.08	96.78
7.	Cabbage	✓	2.72	89.88
8.	Cauliflower	x	2.57	80.65
9.	Broccoli	x	2.64	83.25
10.	Radish	x	2.16	98.15
CD (p=0.05)		-	0.24	6.78
S. Ed		-	0.12	3.38

Table 4: Mean Performance of different microgreens for yield attributes.

S. No.	Microgreen	Shoot length (cm)	Vigour index	Fresh weight (g/tray)	Dry weight (%)	Days to harvest (days)
1.	Amaranathus	6.32	596.29	48.59	3.65	10.34
2.	Carrot	4.26	382.46	52.56	4.22	14.31
3.	Spinach	4.52	441.33	13.05	1.10	12.56
4.	Beetroot	5.78	530.26	10.09	0.91	14.89
5.	Onion	6.05	448.97	23.51	1.61	16.00
6.	Fenugreek	5.79	560.36	43.38	3.28	13.21
7.	Cabbage	6.23	559.95	27.18	2.57	9.76
8.	Cauliflower	7.32	590.36	31.94	2.50	11.78
9.	Broccoli	6.20	516.15	36.17	2.68	10.78
10.	Radish	7.45	733.53	63.47	4.76	8.62
CD (p=0.05)		0.81	80.82	2.51	0.24	1.45
S. Ed		0.40	40.41	1.25	0.12	0.73

Microgreens are harvested when the desired height is attained and first set of cotyledon leaves and true leaves appear. The time from seeding to harvest greatly varied for crops from 1 to 3 weeks Allende *et al*. (2014); Xiao *et al*. (2014b). These are ready for harvest when they reach the first true leaf stage. Radish microgreens matured earlier and were harvested at 8.62 days, followed by cabbage (9.76 days). Onion had a delayed harvest of 16 days. According to this study, radish, fenugreek, spinach, amaranthus, cabbage, cauliflower and broccoli were fast growing and were harvested between 9–13 days; whereas carrot, onion and beetroot being slower at growth were harvested at about 14–16 days.

Conclusion

Microgreens, though a new concept, they have been adopted right from ancient times. They also serve an imperial role in the kitchens of high-end restaurants. Though several studies on nutrient management, fortification and growing methods are available, a proper production technology for huge scale commercialization is the need of the hour. Through this paper, though the production aspects of all the greens are not available, some of the most important and unique greens are elaborated which can further be adopted for cultivation in large scale.

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