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Assessment of sixteen different herbs for their suitability as antioxidant rich microgreens

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ABSTRACT

The study was carried out to evaluate 16 vegetable microgreens for morphological, sensory, and biochemical traits during the year 2023–24 at Dr Rajendra Prasad Central Agricultural University, Samastipur, Bihar. Significant variations were observed in growth characteristics, with radish (*Raphanus sativus* L.) demonstrating the fastest germination (2.30 days) and highest germination percentage (94.10%). Broccoli (*Brassica oleracea* var. *italica*) had the longest stem length (10.20 cm), while celery (*Apium graveolens* L.) had the shortest (3.93 cm). Biochemical analysis revealed significant variations in chlorophyll content with fenugreek (*Trigonella foenum* L.) and radish having the highest levels while total phenol content was highest in fenugreek and Brussels sprouts (*Brassica oleracea* var. *gemmifera*). Antioxidant activity was measured by 2,2-diphenyl-1-picrylhydrazyl (DPPH) and Ferric Reducing Antioxidant Power (FRAP) assays. Lower DPPH activity showed strong antioxidant potential in fenugreek and carrot. While, high FRAP values indicated strong antioxidant capacity as evident in radish and carrot (*Daucus carota* subsp. *sativus*). Sensory evaluation on 9 point hedonic scale showed overall acceptability ranging from 5.5–9.0, with lettuce receiving notably low scores. The study highlighted the diversity and potential of microgreens as a rich source of antioxidants and other beneficial compounds.

Keywords: Anti-oxidant potential, Bio-chemical characterization, Herbs, Microgreens, Nutri-dense food, Vegetables

Microgreens, the new superfood, are tender seedlings of vegetables, herbs or grains, are becoming increasingly popular as a category of functional foods due to their vibrant appearance and rich nutritional profile (Kyriacou *et al.* 2019). Harvested at the cotyledon or first true leaf stage, these young greens often contain higher levels of essential nutrients like vitamins, minerals, and antioxidants compared to their mature forms (Xiao *et al.* 2012). With growing interest in health-conscious and sustainable diets, microgreens are emerging as a valuable, eco-friendly food option. The physical traits of microgreens such as plant height, leaf shape and size, colour, and texture play a crucial role in their growth performance, ease of harvesting, and market appeal. These morphological features are key to identifying promising cultivars suitable for large-scale production. Variations in these traits among different species and varieties can affect both yield and uniformity which are important for commercial success. Although the popularity of microgreens continues to rise, research focusing specifically on their morphological and nutritional profile (Ghoora *et al.* 2020, Gunjal *et al.* 2024) remains limited specially in Indian context except a few researches in consumer acceptance (Rawat *et al.* 2024). Gaining insights into these physical attributes is important for selecting the best-performing crops and for refining cultivation techniques. This study focused on assessing the morphological and bio-chemical traits of a range of vegetable microgreens to identify high-performing and suitable crops. The study examined their nutritional composition, supporting the role of microgreens as a sustainable and health-promoting component of modern diets.

MATERIALS AND METHODS

The present study was carried out at a temperature-controlled polyhouse in vertically placed racks during the year 2023–24 at Dr Rajendra Prasad Central Agricultural University, Samastipur (26.01°N, 85.72°E), Bihar. The microgreens seeds of 16 different vegetable crops were procured from ICAR-Indian Agricultural Research Institute, Katrain, Himachal Pradesh; Tirhut College of Agriculture Dholi, Bihar and Mahyco Seeds (Table 1). These microgreen seeds were sown in sterile cocopeat as the growing medium in plastic perforated microgreen trays measuring 16 cm ×

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10 cm. The seed density for each microgreen species was determined by conducting a separate experiment under the project 'Identification of suitable herbs as microgreen and their biochemical profiling'. The seed density of each microgreen species was determined by proportionally scaling the recommended high density seed rate to the experimental tray area of 112 cm^2 resulting in species specific seeds rate (Table 1). The microgreens were irrigated at two-day intervals with no additional chemical/fertiliser/pesticide treatment throughout the growing period, ensuring the cultivation remained fully organic and chemical free. Most of the morpho-metric parameters were recorded at the time of harvesting, and organoleptic parameters were assessed using a 9-point hedonic scale.

The biochemical parameters were standardised and modified as per the requirements and the data was recorded at the stage of harvesting of fresh microgreens i.e. two fully expanded cotyledon leaf stage for each microgreen species under study. The microgreens were harvested and analysed for their biochemical traits or kept under -20^{o}C till further processing. All of the biochemical data was recorded in three independent growing cycle in triplicate with three biological replications. The estimation of chlorophyll was done by extraction in 70% Dimethyl sulphoxide (DMSO), in accordance with established methodologies outlined in the literature Blanke *et al.* (1992), expressed in mg/100 g fresh weight (FW). The quantification of total phenols was done using the Folin-Ciocalteau method, as described by Vinson *et al.* (1998), and the results were expressed as milligrams of gallic acid equivalents (GAE) per 100 g FW.

This study utilised two commonly employed assays; 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay, which evaluates the hydrogen-donating capacity to scavenge DPPH radicals, and the Ferric Reducing Antioxidant Power (FRAP) assay, an electron transfer-based method. The DPPH scavenging activity was determined according to the methodology outlined by Braca *et al.* (2001), with results expressed as IC_{50} (µg/mL). Moreover, the extract's antioxidant potential was evaluated using the FRAP assay, as referenced by Benzie *et al.* (1996), providing a comprehensive assessment of its antioxidant properties. In DPPH assay, the lower values indicate stronger radical scavenging capacity whereas, in FRAP higher values indicate stronger antioxidant potential. The experimental design followed a completely randomised design (CRD) with three replications and a post hock test i.e. Duncan's New Multiple Range test (DMRT) was used after ANOVA to figure out significant difference in means.

RESULTS AND DISCUSSION

Morpho-metric assessment of selected microgreens: The morphological parameters of microgreens such as germination rate, stem length, root length, leaf size, and biomass yield, play a critical role in determining their overall growth, quality, and suitability for consumption (Sanyukta *et al.* 2023). These traits directly affect the appearance, texture, and nutritional value of microgreens which are essential for both consumer preference and marketability.

Table 1 Details of microgreen species, seed source and seeding density

S. no.	Crops and cultivar	Seed procurement source	Botanical family	Seeding density (g/m²)
1	Cauliflower (Pusa Purple Cauliflower-1)	IARI, Katrain	Brassicaceae	85
2	Cabbage (Pusa Cabbage-1)	IARI, Katrain	Brassicaceae	85
3	Kale (Pusa Kale-64)	IARI, Katrain	Brassicaceae	85
4	Broccoli (Pusa Broccoli KTS-1)	IARI, Katrain	Brassicaceae	85
5	Brussels Sprouts (Hilds Ideal)	IARI, Katrain	Brassicaceae	105
6	Spinach (Virginia Savoy)	IARI, Katrain	Amaranthaceae	244
7	Indian Spinach / *Palak* (*Pusa Harit*)	IARI, Katrain	Amaranthaceae	244
8	Celery (Ford Hook)	IARI, Katrain	Apiaceae	35
9	Coriander (*Rajendra Swati*)	RPCAU, Pusa	Apiaceae	174
10	Parsley (Moss Curled)	IARI, Katrain	Apiaceae	54
11	Amaranthus (*Arka Samraksha*)	IIHR, Bengaluru	Amaranthaceae	39
12	Fenugreek (*Rajendra Kanti*)	RPCAU, Pusa	Fabaceae	271
13	Lettuce (Great Lakes)	IARI, Katrain	Asteraceae	46
14	Beetroot (Crimson Globe)	IARI, Katrain	Amaranthaceae	313
15	Radish (RH-22)	Mahyco Seeds	Brassicaceae	125
16	Carrot (Nantes)	IARI, Katrain	Apiaceae	46

The morphological characteristics of different vegetable microgreens showed significant variation across species (Table 2). The time taken for seed germination ranged from 2.30 days (radish)–12.27 days (coriander). The five fastest growing microgreens were recorded from the members of Brassicaceae family, viz. radish (2.30 days), broccoli (2.60 days), Brussels sprouts (2.60 days), kale (2.63 days), cabbage and cauliflower (3.27 days). Germination percentage was highest in radish (94.10%) followed by lettuce (92.29%), beetroot (91.54%), fenugreek (90.22%), kale (90.92%) and lowest in Brussels sprouts (87.57%). For instance, germination percentage and the time taken for seed germination are crucial indicators of seed quality and vigour, affecting the success rate of microgreen establishment. Faster and uniform germination ensures consistent growth which is desirable for both commercial production and home gardening. Stem length varied significantly, with broccoli having the longest stem (10.20 cm) while celery exhibited the shortest (3.93 cm). Stem diameter was thickest in *palak* (1.03 mm) and thinnest in coriander (0.23 mm). Stem length and diameter are important for determining the structural integrity of the microgreens, affecting ease of harvest, handling, and presentation. Thicker and longer stems may provide better support and facilitate easier harvesting, especially for species that are prone to wilting or damage. Root length ranged from 9.83 cm (celery)–15.80 cm (Brussels sprouts), indicating variability in root development across species at microgreen stage. Previous studies showed significant differences in microgreens shoot height, mostly due to the variation in harvest times and some at the cotyledon stage, others at first true leaves, or after a set number of days (Senevirathne *et al.* 2019, Gunjal *et al.* 2024). Root length is another vital parameter, as strong and well-developed root systems enhance nutrient uptake and support rapid growth, directly impacting the microgreen's nutritional profile.

Leaf size showed similar diversity, with Brussels sprouts having the largest leaf length (8.50 mm) and parsley the smallest (1.50 mm). Leaf width was highest in cabbage (9.33 mm) and lowest in amaranth (1.56 mm). The growing period for microgreens ranged from 8 days (amaranth and radish)–19.45 days (parsley). Leaf size, both length and width, is particularly important for the sensory appeal of microgreens, as larger and healthier leaves often contribute to a better texture and flavour experience (Xiao *et al.* 2015, Bafumo *et al.* 2024). Yield was highest in radish (115.31 g/160 cm^2) followed by broccoli, brussel sprouts, *palak*, cabbage and lowest in celery (40.53 g/160 cm^2). Moisture content was consistently high across all species, ranging from 88.50% (radish)–93.50% (lettuce). Yield and moisture content are critical for evaluating the productivity and freshness of microgreens. Higher yields imply better economic returns, while optimal moisture levels ensure longer shelf life (Priti *et al.* 2022) and reduced post-harvest losses. Dry weight percentages followed an inverse trend, with radish having the highest dry weight (13.26%) and celery the lowest (3.33%). Lastly, dry weight percentage helps assess the nutritional density of

Table 2 Morphological observation of microgreens

Crops	Germination time (days)	Germination (%)	Stem length (cm)	Stem diameter (mm)	Root length (cm)	Leaf length (mm)	Leaf width (mm)	Growing period (days)	Yield (g)	Moisture (%)	Dry weight (%)
Cauliflower	3.27^{h}	88.88^{ab}	8.00^{c}	0.64^{c}	11.83^{cd}	6.20^{b}	8.06^{b}	13.67^{e}	87.56^{f}	89.15^{c}	9.50^{e}
Cabbage	3.27^{h}	89.80^{ab}	9.17^{b}	0.69^{c}	14.53^{ab}	4.50^{d}	9.33^{a}	11.17^{g}	91.14^{e}	91.14^{ab}	8.22^{f}
Kale	2.63^{i}	90.92^{ab}	9.13^{b}	0.65^{c}	12.10^{cd}	5.26^{c}	8.46^{b}	10.17^{h}	90.11^{e}	92.64^{a}	7.80^{g}
Broccoli	2.60^{i}	90.29^{ab}	10.20^{a}	0.58^{d}	13.83^{b}	5.60^{c}	7.20^{b}	12.50^{f}	110.24^{b}	88.60^{c}	12.40^{b}
Brussels sprouts	2.60^{i}	87.57^{ab}	6.80^{d}	0.63^{c}	15.80^{a}	8.50^{a}	10.13^{a}	12.00^{f}	102.56^{c}	89.82^{bc}	10.44^{d}
Spinach	3.97^{g}	92.54^{a}	7.70^{cd}	0.48^{e}	11.20^{d}	3.46^{e}	3.06^{e}	9.52^{i}	90.11^{e}	91.85^{ab}	7.60^{g}
Palak	4.98^{e}	86.14^{bc}	6.70^{d}	1.03^{a}	13.13^{bc}	3.60^{e}	4.46^{d}	12.17^{f}	100.45^{d}	88.80^{c}	11.25^{c}
Celery	8.96^{c}	84.73^{c}	3.93^{g}	0.27^{g}	9.83^{e}	1.33^{f}	2.06^{f}	16.51^{c}	40.53^{m}	92.53^{a}	3.33^{l}
Parsley	10.93^{b}	84.94^{c}	5.87^{e}	0.27^{g}	10.93^{d}	1.50^{f}	1.90^{fg}	19.45^{a}	55.79^{k}	91.93^{ab}	4.50^{j}
Amaranth	4.27^{f}	90.88^{ab}	4.90^{f}	0.94^{b}	12.20^{cd}	5.56^{c}	1.56^{g}	8.40^{j}	50.33^{l}	88.81^{c}	5.63^{i}
Lettuce	3.30^{h}	92.29^{a}	9.90^{a}	0.61^{d}	13.76^{b}	8.53^{a}	5.43^{c}	9.40^{i}	60.75^{j}	93.50^{a}	4.22^{k}
Fenugreek	4.95^{e}	90.22^{ab}	6.97^{d}	0.55^{d}	11.30^{d}	6.26^{b}	6.73^{b}	15.43^{d}	75.56^{h}	91.82^{ab}	7.50^{h}
Beetroot	3.30^{h}	91.54^{a}	8.07^{c}	0.42^{e}	14.90^{a}	1.49^{f}	4.73^{d}	18.33^{b}	80.23^{g}	90.27^{b}	7.28^{h}
Radish	2.30^{j}	94.10^{a}	10.33^{a}	0.66^{c}	14.54^{ab}	1.65^{f}	1.54^{g}	8.00^{k}	115.31^{a}	88.50^{c}	13.26^{a}
Carrot	7.63^{d}	89.80^{ab}	6.53^{d}	0.36^{f}	13.10^{bc}	1.24^{f}	1.33^{g}	19.30^{a}	60.33^{j}	92.44^{a}	4.45^{j}
Coriander	12.27^{a}	86.06^{bc}	7.80^{c}	0.23^{g}	10.96^{d}	6.70^{b}	1.90^{fg}	8.40^{j}	68.55^{i}	88.82^{c}	7.66^{g}
SEM±	0.11	1.69	0.21	0.15	0.34	0.18	0.13	0.28	0.44	1.15	0.06
CD (p=0.01)	0.40	6.58	0.81	0.06	1.34	0.70	0.52	1.09	1.71	4.48	0.23
CV (%)	3.75	3.29	4.79	4.80	4.72	4.54	4.00	3.82	4.71	2.19	4.48

microgreens, as a higher dry weight typically indicates a higher concentration of essential nutrients like vitamins, minerals, and antioxidants.

Kyriacou *et al.* (2019) studied genotypic variation in the nutritive and phytochemical composition of 13 microgreens spp. and found similar trend. These observations highlight the diversity in morphological traits among different vegetable microgreens, which can influence their nutritional value, cultivation practices, and overall suitability for various growing conditions.

Biochemical profiling of 16 microgreens: The biochemical profile of various vegetable microgreens showed significant variation (Table 3). Fenugreek recorded the highest total chlorophyll content at 58.77 mg/100 g FW, followed closely by radish. Kale also exhibited a relatively high total chlorophyll content. In contrast, beetroot had the lowest total chlorophyll content, registering only 15.45 mg/100 g FW. Total chlorophyll content of fenugreek was slightly lower than the values reported by Ghoora *et al.* (2020), where fenugreek had a total chlorophyll content of 59.2 mg/100 g FW.

The variations in total phenol content and antioxidant activity represented by DPPH value and FRAP values among tested microgreen species highlight the importance of considering genetic makeup of genotypes for their nutritional and antioxidant properties. Total phenol content differed significantly among microgreen species. Fenugreek (6.59 mg GAE/g) and Brussels sprouts (6.44 mg GAE/g) had the highest levels, while parsley (2.24 mg GAE/g) and cauliflower (2.25 mg GAE/g) had the lowest.

The total phenol content in microgreens measured in this study presents some significant differences when compared to values from previous research. In the present study, fenugreek had the highest total phenol content (6.59 mg GAE/g), followed closely by amaranth (6.34 mg GAE/g) and Brussels sprouts (6.44 mg GAE/g). These values are considerably higher than the total phenol contents reported for FW samples in earlier studies. For example, Marchioni *et al.* (2021) reported much lower phenol contents for broccoli (3.63 mg GAE/100 g FW) and radish (3.25 mg GAE/100 g FW), while Gunjal *et al.* (2024) found phenol content ranging from 241.98–667.48 mg GAE/100 g FW depending on the growth medium for radish. For beetroot, the current study recorded a phenol content of 5.59 mg GAE/g, which aligns more closely with the higher values reported by Acharya *et al.* (2021) (678.01 mg GAE/100 g DW) and Stajcic *et al.* (2024) (577.0 mg GAE/100 g DW). Similarly, broccoli (5.81 mg GAE/g) exceeded values reported by Xiao *et al.* (2019) and Marchioni *et al.* (2021), who observed phenol contents of 282.8 mg GAE/100 g FW and 3.63 mg GAE/100 g

Table 3 Biochemical composition of different microgreens

Crops	Chlorophyll a (mg/100 g FW)	Chlorophyll b (mg/100 g FW)	Total chlorophyll (mg/100 g FW)	Total phenol (mg GAE/g)	DPPH (IC_{50}) (µg/mL)	FRAP (µmol TE/g)
Cauliflower	34.45^{c}	15.01^{e}	49.47^{c}	2.25^{j}	220.28^{b}	6.23^{o}
Cabbage	28.18^{f}	14.59^{f}	42.77^{f}	4.46^{h}	190.42^{c}	8.55^{i}
Kale	36.44^{b}	16.13^{d}	52.57^{b}	3.84^{i}	250.39^{a}	7.58^{k}
Broccoli	31.73^{d}	15.42^{e}	47.15^{d}	5.81^{c}	170.41^{d}	7.73^{j}
Brussels sprouts	30.73^{e}	17.18^{c}	47.92^{d}	6.44^{b}	240.57^{b}	8.63^{h}
Spinach	25.77^{h}	11.34^{h}	37.11^{h}	3.81^{i}	140.25^{f}	10.55^{e}
Palak	27.09^{g}	12.10^{g}	39.19^{g}	4.05^{hi}	160.32^{e}	9.57^{f}
Celery	20.47^{j}	9.01^{j}	29.48^{j}	2.59^{j}	175.28^{d}	12.55^{d}
Parsley	22.22^{i}	14.25^{f}	36.48^{h}	2.24^{j}	195.16^{c}	11.53^{c}
Amaranth	30.20^{e}	17.84^{b}	48.04^{d}	6.34^{b}	110.74^{h}	6.59^{n}
Lettuce	25.89^{h}	15.80^{d}	41.60^{f}	5.92^{c}	125.21^{g}	8.50^{i}
Fenugreek	38.18^{a}	20.59^{a}	58.77^{a}	6.59^{a}	98.52^{i}	10.53^{e}
Beetroot	10.48^{k}	4.97^{k}	15.45^{k}	5.59^{d}	120.31^{g}	5.55^{p}
Radish	37.37^{ab}	19.65^{a}	57.03^{a}	6.38^{b}	167.01^{e}	18.66^{a}
Carrot	24.96^{h}	16.01^{d}	40.98^{f}	4.12^{h}	98.66^{i}	15.65^{b}
Coriander	31.10^{d}	16.22^{d}	47.32^{d}	5.56^{d}	106.70^{h}	14.62^{b}
SEM±	0.24	0.20	0.35	0.06	0.76	0.03
CD (p=0.01)	0.95	0.78	1.36	0.25	2.93	0.12
CV (%)	1.50	2.37	1.41	2.37	0.81	0.53

DPPH, 2,2-diphenyl-1-picrylhydrazyl; FRAP, Ferric reducing antioxidant power.

FW, respectively. These differences could arise due to the drying process, which concentrates phenols in dry weight measurements, or could reflect genetic and environmental differences.

Findings showed notable differences compared to previous studies, potentially due to differences in the genetic makeup of varieties chosen. DPPH IC_{50} values indicated antioxidant activity, varied significantly among the microgreen species studied. The genotype that showed strongest antioxidant potential was fenugreek (98.52 µg/mL) and carrot (98.66 µg/mL) exhibited the strongest antioxidant potential. Kowitcharoen *et al.* (2021) reported much higher activity for broccoli microgreens, with 35.56 mM TACE/g, which is stronger than the current study's IC_{50} value of 170.71 µg/mL. Xiao *et al.* (2019) also reported significantly higher antioxidant capacities for red kale (260.1 µmol TE/100 g FW), Brussels sprouts (228.9 µmol TE/100 g FW), and radish (279.8 µmol TE/100 g FW), when compared to the present study's corresponding results. These variations could be attributed to differences in the plant varieties, growth conditions, or methods used for evaluating antioxidant activity across studies.

The Ferric Reducing Antioxidant Power (FRAP) values obtained in this study displayed notable differences compared to previous findings, likely due to differences in the measurement basis (dry weight vs. fresh weight), growing conditions, and varieties used. For instance, the current study found a FRAP value of 18.66 µmol TE/g for radish, which is consistent with the findings of Ghoora *et al.* (2020) (22.7 µmol Fe^{2+}/g FW) and Yadav *et al.* (2019) (17.77 µmol TE/g FW). These similar values highlight that radish is a rich source of antioxidants, irrespective of the weight basis or variety. Spinach in this study had a FRAP value of 10.55 µmol TE/g, closely aligning with Ghoora *et al.* (2020) who reported 10.4 µmol Fe^{2+}/g FW, suggesting consistency in antioxidant activity for spinach across studies.

Similarly, the fenugreek FRAP value of 10.53 µmol TE/g in the current study is almost identical to the 10.0 µmol Fe^{2+}/g FW reported by Ghoora *et al.* (2020) further indicating that fenugreek consistently demonstrates high antioxidant capacity. Amaranth had a FRAP value of 6.59 µmol TE/g in the current study, whereas Gunjal *et al.* (2024) reported a significantly lower value of 2.30 µmol TE/g FW for red amaranth, and Yadav *et al.* (2019) recorded 2.15 µmol TE/g FW for green amaranth. In carrot, the present study recorded a FRAP value of 15.65 µmol TE/g, somewhat lower than the 17.8 µmol Fe^{2+}/g FW reported by Ghoora *et al.* (2020), which may reflect varietal or environmental differences. The beetroot in this study exhibited a FRAP value of 5.55 µmol TE/g, closely matching Gunjal *et al.* (2024) who reported 5.25 µmol TE/g FW, indicating a similar level of antioxidant capacity. Kyriacou *et al.* (2019) studied different families of microgreen species and found highest antioxidant capacity in brassicaceous microgreens and significant genotypic variation was demonstrated in chlorophyll and carotenoid concentrations. In the same study, high phenolic content was confirmed in Lamiaceae microgreens, with significant varietal differences, and alternative phenolics-rich microgreens from the Apiaceae were identified. The study found that radish exhibited the highest FRAP value. FRAP values for radish, spinach, and fenugreek were comparable to previous studies. High antioxidant levels help protect cells from oxidative stress, reducing the risk of chronic diseases like cancer and diabetes. Additionally, microgreens can aid in digestion and promote healthy skin due to nutrient content. Their dense biochemical profile makes them a powerful, nutrient-rich food in small servings.

Sensory profiling of microgreens: Sensory observation is crucial for microgreens as it helps assess key quality traits like colour, texture, flavour, and aroma which directly influence consumer appeal and market value. Evaluating these sensory attributes allows producers to select varieties that are not only nutritious but also visually and texturally pleasing, enhancing their desirability in culinary applications and ensuring a positive eating experience. It reflects the consumer's overall satisfaction and likelihood to choose or recommend the product.

The study noted beetroot (8.4) as rated highest for overall acceptability, followed by radish (8.3) and carrot (8.2) (Table 4). Lettuce (2.1) was rated the lowest in this category, showing that it was the least liked overall. Nutritional values dictate first step of consumer acceptance of a food product, closely followed by sensory attributes, viz. appearance, texture, and flavour (Cavallo *et al.* 2018). Appearance dominates consumer choice while other attributes sustain

Table 4 Rating of 16 different microgreens on 9 point Hedonic scale for sensory quality

Microgreen crops	Appearance	Aroma	Taste	Texture	Overall acceptability
Cauliflower	8.2	7.5	5.1	5.6	6.2
Cabbage	7.5	5.5	6.3	5.8	6.8
Kale	7.6	6.1	6.4	7.4	7.1
Broccoli	8.2	6.4	7.3	5.2	6.5
Brussels sprout	7.5	7.2	5.6	6.4	6.7
Spinach	6.3	6.5	7.2	7.6	7.2
Palak	7.4	7.1	7.5	4.6	7.5
Celery	5.6	7.2	6.8	5.7	7.3
Parsley	6.9	8.2	6.6	6.2	7.4
Amaranth	7.9	7.5	8.1	7.3	8.1
Lettuce	7.5	3.4	3.5	7.6	2.1
Fenugreek	7.6	9.5	6.8	8.1	7.9
Beetroot	9.5	7.9	8.6	8.7	8.6
Radish	9.1	7.1	4.6	7.2	8.3
Carrot	7.8	8.6	8.5	8.2	8.2
Coriander	8.6	8.4	8.2	7.3	8.4

future purchases (Barrett *et al.* 2010). Overall acceptability is the general impression or rating of the microgreens based on a combination of all sensory attributes (appearance, aroma, taste, and texture). There have been several studies about how sensory attributes and visual appearance influence consumer perception towards microgreens per se Michell *et al.* (2020) while some have done comparative studies at different maturity stages (Senevirathne *et al.* 2019).

Micro-greens are a novel class of vegetable greens with ease of cultivation, and culinary diversity and very short growing cycle. These findings highlight the diversity in morphological, and biochemical traits among microgreens, emphasising species like radish, broccoli, and beetroot for superior growth, and nutritional value. Comparative evaluation of 16 microgreen species revealed significant genotypic variation in agronomic performance and antioxidant chemistry, with radish emerging as the most promising candidate across all assessed parameters. Radish exhibited the fastest germination (2.30 days), highest germination percentage (94.10%), maximum fresh yield (115.31 g), and highest dry matter accumulation (13.26%), underscoring its superior biomass productivity and commercial viability. These findings collectively demonstrate that microgreen selection must be criterion-specific: radish, broccoli, Brussels sprouts, kale, and *palak* are recommended for yield-oriented production, whereas radish, fenugreek, carrot, amaranth, and coriander represent the most promising for nutraceutical and functional food applications requiring elevated antioxidant bioactivity. This study provides valuable insights for selecting and cultivating microgreens to meet consumer preferences and optimise production practices. The findings underscore the potential of microgreens as a nutrient-dense food source, valuable for both health-conscious consumers and agricultural practices aimed at improving dietary quality.

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