

Microgreens: The tiny nutritional powerhouse

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Microgreens are young, tender, edible seedlings harvested 7–21 days after sowing, positioned between sprouts and baby greens, and valued for their intense flavour, vibrant colour, delicate texture and visual appeal. They are considered 'super foods' due to their high nutritional status, often containing 30–40 times higher levels of vitamins, minerals and anti-oxidants than mature vegetables. Microgreens can be grown year-round in limited spaces using soil or soilless systems, making them suitable for urban and sustainable agriculture. Their short growth cycle, low input requirements and high market value offer strong economic potential while supporting improved nutrition and health.

Keywords: Functional foods, Health benefits, Nutritious value, Sustainable production

MICROGREENS are young, tender, edible seedlings harvested at a very early stage of plant development, usually at the cotyledonary stage or shortly after the emergence of the first true leaves. They are typically harvested above the root zone, leaving the root system in the growing medium and are developmentally positioned between sprouts, which are consumed entirely including roots and seeds as well as baby greens, which are harvested at a more advanced vegetative stage. Microgreens are valued not only for their tender texture and rapid growth cycle but also for their intense and distinctive flavours, vibrant colours and high visual appeal. These characteristics make them particularly attractive for use in gourmet cuisine, salads, garnishes and specialty food preparations. Beyond their sensory qualities, microgreens are increasingly recognised for their exceptional nutritional profile. Numerous studies have reported that

microgreens often contain higher concentrations of vitamins (such as vitamins A, C, E and K), essential minerals, antioxidants and other bioactive compounds compared to their mature counterparts. This nutrient density has positioned microgreens as functional foods with potential health-promoting properties, contributing to their growing popularity among health-conscious consumers, nutritionists and the food service industry.

From an agricultural and socio-economic perspective, agriculture remains central to ensuring food and nutritional security, income generation and sustainable livelihoods worldwide. However, contemporary challenges such as rapid urbanisation, shrinking arable land, climate variability and increasing demand for safe, nutritious and sustainably produced food have necessitated the adoption of innovative and resource-efficient production systems. Consumer preferences are increasingly shifting toward fresh,

minimally processed, low-calorie and nutrient-rich foods that align with health and wellness trends. These changing demands have accelerated interest in alternative cropping systems, particularly in urban and peri-urban environments where land availability is limited and production must be optimised.

Microgreens can be produced throughout the year under diverse growing conditions, including confined spaces such as balconies, rooftops, windowsills and controlled indoor environments. Its rapid growth cycle, high market value and compatibility with soilless, vertical and indoor farming systems make them an economically viable option for both rural and urban communities. Moreover, the cultivation of microgreens aligns with the principles of sustainable agriculture by reducing the environmental footprint of food production while contributing to dietary diversification and improved human nutrition.

Market trend

The global microgreens market has experienced rapid growth in recent years, expanding from USD 2.14 billion in 2024 to USD 2.39 billion in 2025, at a compound annual growth rate (CAGR) of 11.3%. This growth has been driven by increasing consumer awareness of healthy diets, rising adoption of microgreens by restaurants and foodservice industries, growth of urban agriculture and home gardening and recognition of microgreens as nutrient-dense functional foods. Their popularity has been further supported by changing food preferences toward fresh, premium and locally produced ingredients.

Looking ahead, the microgreens market is expected to continue its strong upward trajectory, reaching USD 3.88 billion by 2029 at a CAGR of 12.9%. Growth during the forecast period is attributed to the increasing emphasis on sustainable and eco-friendly farming practices, rising demand for organic and premium-quality food products and expanding applications in the foodservice and cosmetic industries. Technological advancements such as indoor vertical farming, hydroponics, artificial intelligence-based monitoring systems and the development of biofortified microgreens are also emerging as key market trends, enhancing productivity, nutritional value and year-round availability.

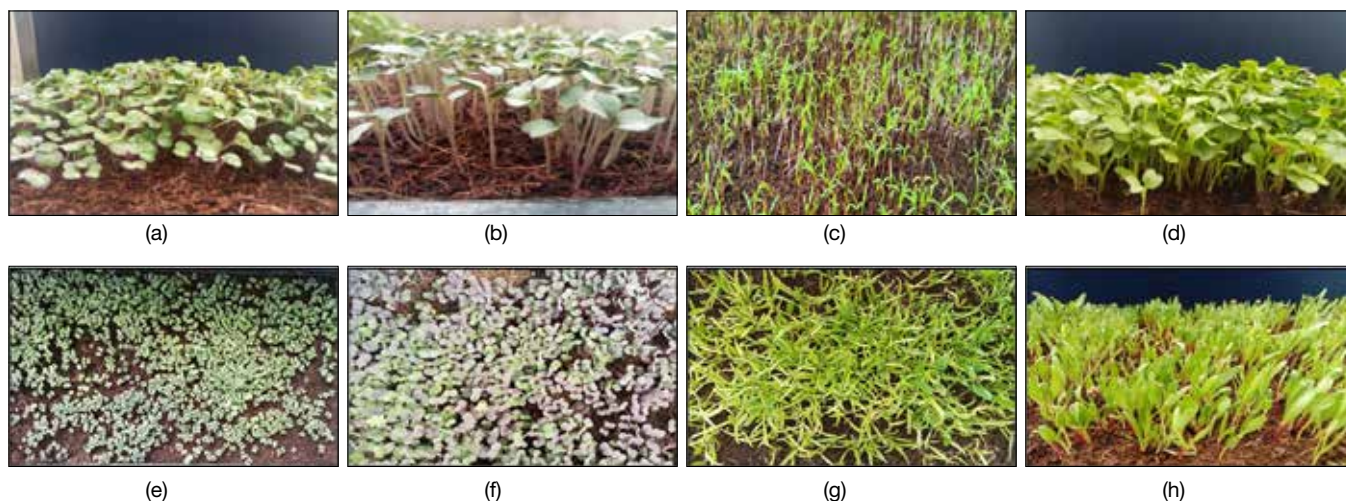
Table 1. List of crops explored for microgreens

Family	Common name	Scientific name	Number of seed or g/m ²	Microgreen colour
Brassicaceae	Cauliflower	<i>Brassica oleracea</i> var. <i>botrytis</i>	~30,000–40,000 seeds/m ² (100–120 g/m ²)	Green
	Cabbage	<i>Brassica oleracea</i> var. <i>capitata</i>	~30,000–40,000 seeds/m ² (80–100 g/m ²)	Green
	Kale	<i>Brassica oleracea</i> var. <i>acephala</i>	~30,000–40,000 seeds/m ²	Green
	Broccoli	<i>Brassica oleracea</i> var. <i>italica</i>	~30,000–40,000 seeds/m ² (100–120 g/m ²)	Purplish Green
	Brussels sprouts	<i>Brassica oleracea</i> var. <i>gemmifera</i>	~30,000–40,000 seeds/m ²	Green
	Radish	<i>Raphanus sativus</i>	~30,000–46,000 seeds/m ²	Green / Purplish Green
Chenopodiaceae	Spinach	<i>Spinacia oleracea</i>	~30,000–46,000 seeds/m ²	Green
	Palak (Indian spinach)	<i>Beta vulgaris</i> var. <i>bengalensis</i>	~60,000 seeds/m ²	Green
	Beetroot	<i>Beta vulgaris</i>	~60,000 seeds/m ²	Reddish Green
Apiaceae	Celery	<i>Apium graveolens</i>	~80,000 seeds/m ² (50–100 g/m ²)	Green
	Parsley	<i>Petroselinum crispum</i>	~30,000–40,000 seeds/m ²	Green
	Carrot (European type)	<i>Daucus carota</i>	~200 g/m ²	Greenish yellow
	Coriander	<i>Coriandrum sativum</i>	~200–250 g/m ²	Green
Amaranthaceae	Amaranth	<i>Amaranthus tricolor</i>	~30,000 seeds/m ² (50–60 g/m ²)	Green / Red
Asteraceae	Lettuce	<i>Lactuca sativa</i>	~180 g/m ²	Green
Fabaceae	Fenugreek	<i>Trigonella foenum-graecum</i>	~30,000–40,000 seeds/m ²	Green

Potential crops for microgreens production

Vegetable seeds are commonly utilised in the production of quality

microgreens due to their richness in essential nutrients and antioxidant compounds. Examples are given under Table 1.



Microgreens of various species: (a) Cabbage, (b) Broccoli, (c) Carrot, (d) Radish, (e) Turnip (f) Brussels sprouts, (g) Palak, (h) Spinach

Nutritional importance and health benefits

Microgreens are celebrated as functional foods owing to their exceptionally high concentrations of essential nutrients compared to mature plants. They contain 30–40 times higher levels of vitamins, minerals, anti-oxidants and bioactive compounds, accumulated during the brief photosynthetic period following germination. The key nutrients include vitamins such as, C, E, K and A, along with minerals such as iron, zinc, potassium, calcium and magnesium. Many varieties provide substantial portions of daily recommended intakes of these elements, making them effective in combating micronutrient deficiencies.

Microgreens rich phytochemical profile confers multiple health benefits, including antioxidant, anti-inflammatory, anti-diabetic, anti-cancerous and cardiovascular protective properties. Its regular consumption helps in preventing diet-related non-communicable diseases, support immune function, improve metabolic health and address issues like anemia and oxidative stress. For population facing dietary imbalances or vegetarian diets with lower nutrient bioavailability, microgreens offer a concentrated, accessible source of essential elements. Additionally, their low levels of anti-nutrients, such as nitrates and oxalates ensure safe consumption. Among the mentioned microgreens, celery has highest amount of calcium followed by parsley and *palak*. Fenugreek and *palak* contain highest amount of iron and zinc while potassium is found highest in *palak* followed by amaranth and cauliflower microgreen.

Cultivation of microgreens at home

Successful microgreens production depends on careful selection of crops and seeds, sowing density, growing medium and environmental conditions. Ideal substrates provide adequate porosity, water-holding capacity, aeration and a neutral pH range of 5.5–6.5, while being free from contaminants. Common options

include soil, cocopeat, vermiculite, perlite, vermicompost and hydroponic systems. Cocopeat based mixtures are widely utilised due to their affordability, biodegradability and effectiveness in supporting uniform growth.

Seed density varies with crop; e.g. lettuce and coriander require higher seed per unit area, while larger seeds (e.g. beetroot, fenugreek) have lower seed density. Indoor or controlled environments with natural or supplemental lighting promote optimal development. Water requirements are significantly lower than for mature crops, with microgreens often using 150–200 times less water to deliver equivalent nutrients. Techniques such as hydroponics, aquaponics and vertical farming further enhance input use efficiency with year-round production.

Microgreens are harvested when cotyledons and first true leaves become fully expanded, typically 7–21 days after sowing (DAS), depending on the species. Manual cutting just above the substrate is the standard for small-scale operations, ensuring cleanliness and minimising damage.

Table 2. The optimum harvesting time for selected microgreens

Harvesting time (days after sowing)	Microgreens
6–9	Amaranth, broccoli, cabbage, cauliflower, kale, spinach, fenugreek, beetroot, radish, carrot
10–12	Amaranth, broccoli, cabbage, cauliflower, brussels sprouts, spinach, palak (Indian spinach), fenugreek, radish, carrot
13–15	Amaranth, cabbage, kale, spinach, lettuce, fenugreek, beetroot, radish, celery, parsley
16–18	Coriander
19–21	Amaranth, broccoli, lettuce, beetroot



(a)



(b)

Fresh harvested microgreens: (a) Brussels sprouts and (b) Spinach

Sensory attributes and consumer acceptance

The appeal of microgreens largely stems from their visual vibrancy, intense flavours and delicate textures. Sensory qualities vary widely: some varieties offer mild, sweet taste while others are pungent, bitter or astringent. Crops like, amaranth, beetroot, coriander and Swiss chard generally receive higher consumer preference due to balanced flavour profiles, whereas strongly bitter or sour types (e.g. red cabbage, sorrel) score lower preference. Overall consumer acceptability correlates with aroma, taste and familiarity, with knowledge of nutritional benefits.

Culinary applications and value-added products

Microgreens are highly perishable, with a typical refrigerated shelf life of 3–10 days and are therefore best consumed fresh. They are widely used as garnishes and flavour enhancers in salads, soups, sandwiches, smoothies, pizzas and traditional dishes. Additionally, incorporation into everyday meals such as curries, omelets, flatbreads, or yogurt-based preparations improves dietary

quality without overpowering taste. In addition to fresh use, microgreens can be processed to extend shelf life and diversify their applications. Dried microgreens powder can enrich baked products, crackers, muffins and breads with proteins, fibre and anti-oxidants. Functional beverages combining microgreen juices with fruits or herbs provide nutrient-dense and refreshing options. Other innovative products include fortified snacks, hummus and energy drinks, highlighting the potential of microgreens to enhance nutrition and food security.

Sustainability and environmental benefits

Microgreens cultivation is inherently resource-efficient, requiring minimal land, water, fertilisers and time. Indoor or

urban setups reduce transportation emissions, while short cycles and reusable media support eco-friendly practices. This approach is ideal for households, urban farming and peri-urban enterprises, promoting localised food production while reducing dependence on conventional agriculture.

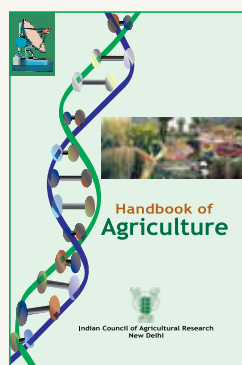
SUMMARY

Microgreens represent a promising functional food, valued for their dense nutrient content, distinctive flavour, texture and health benefits. Their cultivation requires minimal inputs, short growth cycles and low investment, while offering higher profitability and environmental sustainability compared to conventional farming. The adoption of both soil and

soilless cultivation systems in controlled environments facilitates year-round production and meets the growing demand of health-conscious consumers. However, challenges remain, including susceptibility to pests and diseases, short shelf life as well as safety, quality and post-harvest handling. Improving storage, packaging and transport methods will extend shelf life and maintain quality. Expanding consumer awareness, developing nutrient-rich cultivars and exploring novel crops will enhance market potential, stimulate demand and promote sustainable production of microgreens.

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