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Unlocking the Potential of Microgreens: A Step Towards Sustainable Food Systems

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INTRODUCTION:

Across the past ten years, people all across the world have been more interested in consuming fresh, healthful, and functional foods like microgreens and sprouted seeds, particularly during and after the COVID-19 epidemic (Ebert, 2022). They satisfy consumer expectations for novelty and palatability in addition to offering beneficial nutritional contents. Additionally, because they require little in the way of production and reach their maximum consumption in a very short amount of time, they are a very appealing commodity for producers (Treadwell *et al*., 2020). Microgreens, sometimes referred to as "vegetable confetti," are made from a variety of commercial food crops, including grains, herbs, and vegetables, that have completely formed cotyledons with or without partially grown true leaves. Microgreens are tiny, edible greens that are harvested shortly after the seeds germinate. These miniature vegetable greens are produced from various types of vegetables, herbs, and other plant varieties. They are typically harvested when the plants are between 1 to 3 inches tall, which is when they are at their peak in terms of flavor, texture, and nutritional value. The cultivation of microgreens has gained significant popularity in recent years due to their unique flavor profiles, vibrant colors, and impressive nutritional content. They are often referred to as "vegetable confetti" or "nutrient-dense greens" because they pack a powerful punch of vitamins, minerals, and antioxidants into tiny packages. One of the key advantages of microgreens is their rapid growth cycle. Depending on the variety, they can be ready for harvest within 7 to 14 days after sowing the seeds. This makes them an ideal choice for urban gardeners, small-space growers, and those seeking fresh,

locally grown greens year-round. Microgreens are typically grown in hydroponic systems, and their cultivation requires careful attention to factors such as seed quality, growing medium, light, temperature, and moisture levels. With the right growing conditions, microgreens can thrive and provide a continuous supply of fresh, nutritious greens for home cooks and professional chefs alike. (Choe *et al.,* 2018). A center stalk, two mature cotyledon leaves, and a second pair of young true leaves make up microgreens, also referred to as "vegetable confetti," which are soft juvenile greens grown from seeds of cereals, vegetables, and herbs with immature shoots. They are typically harvested 7–21 days after germination and are only a few centimeters tall, or 2.5–7.5 cm. These functional micro vegetables are usually 2–8 cm in height and have intense sensory attributes, such as flavor, texture, aroma, appearance, and exotic colors, irrespective of their small expanse. They are also overloaded with an abundant level of various phytonutrients, varying according to the nature of the plants that are selected to produce the microgreens (Samuoliene *et al*., 2019). Due to its attributable presence of various health-promoting phytonutrients, such as antioxidants, vitamins, minerals, phenolic compounds, and much more health-promoting compounds, they are considered the next generation of “superfoods” or “functional foods”.

Table 1: Comparison of sprouts, microgreens, baby greens and mature plants

Conditions	Sprouts	Microgreens	Baby greens	Mature plants
Height	5-8 cm	3-10 cm	10-15 cm	Several cm
Production time	3-10 days	7-21 days	20-40 days	Several months
Cultivation system	Do not require soil or medium to grow. Grow solely in water or in moisture.	Can be grown in soil or entirely in medium.	May or may not be grown in soil fields. Require medium to grow.	Grown in soil fields. Require medium to grow.
Root appearance	Very tiny root without root hairs.	Small roots with root hairs.	Roots with root hairs.	Mature root system.

Land space	Very small space is required for large scale production also.	Very small space is required for large scale production also.	Require a large area for their growth	Grown over acres of free and open-spaced lands
Harvest type	No harvesting. Wholly edible.	Harvesting is done by removing the roots.	Removing the roots by cutting.	Harvesting is done by cutting the roots either manually or mechanically.

DIFFERENT VARIETIES OF MICROGREENS:

Microgreens are produced both at a small-scale level and along with large scale production of commercial vegetables and edible flowers. Upon their meteoric rise and demand, various varieties of commonly grown vegetables were used to cultivate microgreens that belongs to various family such as amaranthaceae(amaranth, beet, quinoa, spinach, buckwheat, chard), Amaryllidaceae (garlic, onion, leek), Apiaceae (parsley, carrot, fennel, celery, dill, carrot, chervil, cilantro, coriander), Asteraceae (lettuce, radicchio, chicory, endive, tarragon, common dandelion), Boraginaceae (phacelia), Brassicaceae (radish, water cress, arugula, broccoli, cauliflower, cabbage, chicory, wild-rocket), Convolvulaceae (water convolvulus), Cucurbitaceae (melon, cucumber, squash), Malvaceae (jute mallow/Nalta jute), Poaceae (corn, lemongrass), Lamiaceae (chia), Leguminosae (chickpea, alfalfa, bean, green bean, fenugreek, fava bean, lentil, pea, clover), Onagraceae (evening primrose), Portulacaceae (common purslane, moss-ross purslane) (Tan *et al*., 2023)

NUTRIENT AND PHYTOCHEMICAL COMPOSITION OF MICROGREENS:

Indeed, food has played a crucial role in the evolution of human civilization. Calories and critical nutrients that are necessary for human growth, development, and survival are found in food. In many societies, food served as more than just a source of nourishment, prevent and manage a variety of health

problems. The development of humanity is reflected in the current period of food science and nutrition, which has advanced as a result of the integration of knowledge from disciplines like biology, biochemistry, and medicine (Hotamisligil, 2006). Chronic metabolic disorders, which affect human health over a longer period, have always been a looming issue in the health sector. Metabolic disorders usually do not pose an immediate threat to human health but cause other health issues over time and prevail for longer, thus increasing the risk factors among people. Microgreens, which are tiny harvested vegetables with a high density of nutrients, minerals, and phytochemicals, are now in the limelight and are used for various culinary enhancements.

The chemical makeup of microgreens, an emerging food source, has not yet been investigated, and not much data has been recorded. According to certain theories, microgreens are primarily linked to micro and macronutrients like Fe, Zn, K, Ca, N, P, S, Mn, Se, Mo, and others. In addition to these mineral components, microgreens are abundant in biological phytochemicals that have the ability to significantly improve human health and treat illnesses. Major bioactive chemicals are said to be found in the microgreens in higher concentrations. These include ascorbic acid, phytoquinones, tocopherol, carotene, phenolic antioxidants, carotenoids, anthocyanins, glucosesinolates, and sugar content. Also referred to as vitamin C, ascorbic acid is a necessary bioactive phytochemical that is vital to bodily functions. It is also classified as an antioxidant that supports a number of human metabolisms.

Di Bella *et al.* (2018) examined the ascorbic acid content of microgreens and observed variations in ascorbic acid levels at different stages of plant growth, indicating that the ascorbic acid level was possibly higher in the microgreen stage of plant development than in the other stages, such as tenders, baby greens, and mature plants. An-tocopherol is an extremely important phytochemical that is present in micro greens. They are involved in many of the body's functions, especially in nerve impulses, muscle movements, boosting the immune system, limiting free radical formation, and many more important activities. A-carotene is a red–orange organic compound that acts as the precursor of vitamin-A and is a plant metabolite that is especially present in red-

, yellow-, and orange-colored plants. They play a major role in the inhibition of free radicals, induction of apoptosis in cancer cells, and the enhancement of natural killer cell production, thus improving the immune system. Phenolic antioxidants are secondary metabolites that are present in the microgreens that help in promoting metabolic activity, preventing free radical oxidation, and reducing inflammation.

Table 2: Vegetable plants used for Microgreens

Botanical family	Common Vegetables/Plants
Brassicaceae	Cauliflower, Broccoli, Cabbage, Radish, Kale, White mustard, Watercress
Asteraceae	Lettuce, Chicory, Sunflower, Sea Beet
Apiaceae	Dill, Carrot, Fennel, Celery, Coriander
Amaryllidaceae	Onion, Garlic, Sea Fennel
Cucurbitaceae	Melon, Cucumber, Squash
Fabaceae	Mungbean, Chickpea, Green bean, Lentil
Poaceae	Oat, Barley, Wheat
Solanaceae	Tomato, Sweet pepper, Ground cherry

FACTORS AFFECTING MICROGREEN GROWTH AND PRODUCTION:

Seed Quality: Using high-quality, fresh, and untreated seeds is essential for producing healthy and vigorous microgreens. The seed variety and source can significantly impact germination rates, growth, and flavor.

Growing Medium: Microgreens can be grown in various growing media, such as soil, coconut coir, peat moss, or hydroponic systems. The growing medium should be well-draining, nutrient-rich, and free from contaminants.

Light: Adequate light exposure is crucial for microgreen growth and development. Most microgreens thrive under bright, full-spectrum light, either from natural sunlight or grow lights. The intensity, duration, and quality of light can affect factors like stem elongation, leaf color, and flavor.

Temperature: Microgreens prefer a consistent temperature range, typically between 65°F to 75°F (18°C to 24°C). Fluctuations in temperature can affect germination rates, growth patterns, and overall quality.

Humidity: Maintaining proper humidity levels is essential for microgreen cultivation. Too little humidity can lead to drying out, while excessive humidity may promote mold growth or disease development, humidity level varies with crops.

Air Circulation: Proper air circulation is vital for microgreen growth, as it helps prevent the buildup of excess moisture, which can lead to mold or disease issues.

Water and Nutrients: Microgreens require consistent and appropriate watering practices. Overwatering or underwatering can lead to stunted growth, root diseases, or nutrient deficiencies. Providing the right balance of nutrients through fertilizers or nutrient solutions is crucial for optimal growth.

Pest and Disease Management: Proper sanitation, hygiene, and preventive measures are necessary to protect microgreens from pests, diseases, and contamination.

Harvesting Techniques: Careful harvesting techniques, such as using sharp, clean scissors or knives, and harvesting at the appropriate stage, can significantly impact the quality, shelf life, and flavor of microgreens. (Choe *et al.,* 2018).

CONCLUSION:

Microgreens are a novel plant-based functional food made from edible plant seedlings that are harvested after 7–14 days of germination. They are an excellent source of phytochemicals, including essential minerals, polyphenols, carotenoids, chlorophyll, anthocyanins, glucosinolates, and others. These phytochemicals have strong antioxidant, anti-inflammatory, and anti-diabetic effects, making them a useful food that may improve or lessen chronic diseases. Customers can benefit from a variety of health advantages due to the diversity of microgreen species. The role that microgreens play in developing sustainable food systems and urban agriculture. With concentrated levels of vitamins,

minerals, and antioxidants that outweigh those of their more mature counterparts, these little, nutrient-dense plants have outstanding nutritional value. The effective cultivation techniques for microgreens, like hydroponics and vertical farming, are especially well-suited for urban settings with constrained resources and space. Because of these techniques, which optimize resource efficiency, preserve water, and lessen dependency on traditional agricultural inputs, microgreens are a perfect way to address issues with food security in densely populated places.

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Vitamin A: Grow Red Cabbage Microgreens

Vitamin A supports a healthy immune system and healthy skin. An easy way to add more vitamin A to your diet is with ingarden red cabbage microgreens. They contain astonishing +230% more vitamin A per serving compared to fully grown red cabbage.

Vitamin C: Grow Kale Microgreens

Vitamin C is an extremely important vitamin that supports healthy skin and bones. A great way to add vitamin C to your diet is with kale microgreens. ingarden kale microgreens contain +15% of your daily recommended intake per serving!

Zinc: Grow Mustard Seed Microgreens

Zinc helps the body make protein and supports our immune systems. If you're looking for more Zinc in your diet, ingarden mustard microgreens contain +10% more Zinc per serving compared to mature mustard seeds.

Vitamin K: Grow Broccoli Microgreens

Vitamin K is an important vitamin for babies and kids, as it supports healthy bone development. However, is it also important to continue consuming plenty of vitamin K throughout our adult lives to keep our bones strong. ingarden broccoli microgreens contain 10% of your daily recommended intake per serving.