SHORT FEATURE

MICROGREENS

FOOD FOR THE FUTURE

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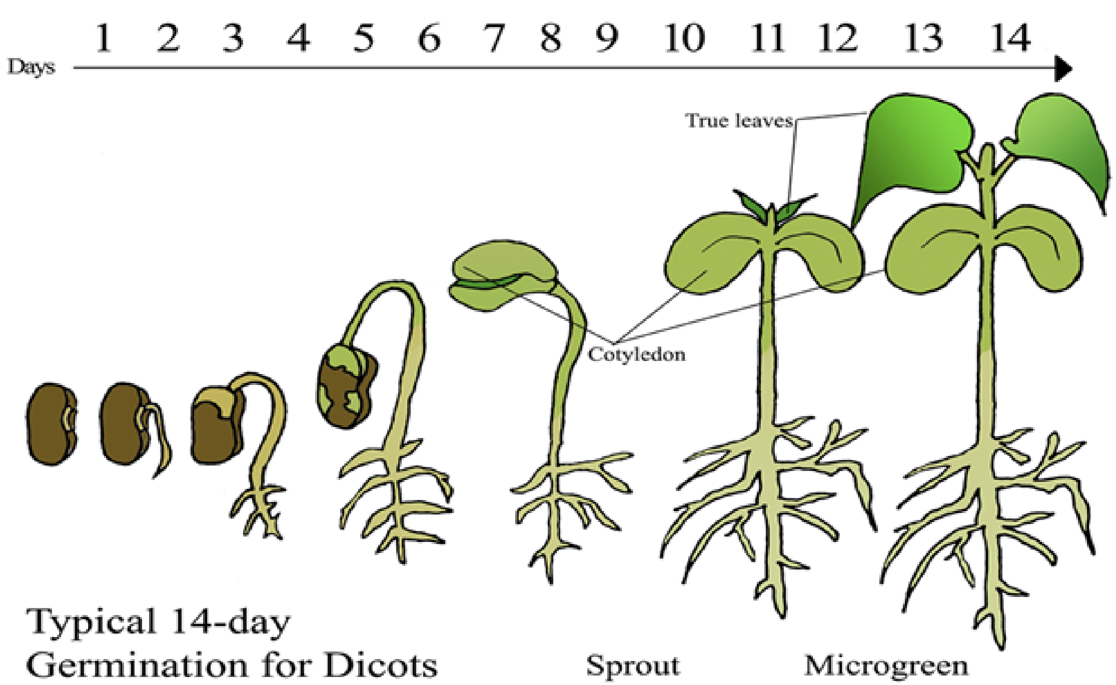
MICROGREENS have in recent times emerged as a new class of edible vegetables. Microgreens are young vegetables, harvested between 10-14 days from seed germination. Their use as culinary ingredients has been mostly because of their ranges of attractive colours, intense flavours and tender texture. Microgreens have also been explored for their potential use in alleviating hunger across the globe.

Microgreens are edible vegetables that are harvested at the soil level when the cotyledons have fully expanded and the first pair of true leaves has emerged – usually within 10-14 days after germination. The size of microgreens is between 1-3 inches depending on the species of the vegetable.

Microgreens thus have three constitutive parts: a central stem, fully expanded cotyledon leaves and a pair of young true leaves. Microgreens are different from sprouts and baby greens. Sprouts are harvested earlier than microgreens. On the contrary, baby greens are harvested much later in the life cycle of vegetables generally between 15-40 days after germination.

However, nitrate content has been reported to be present at a lower concentration in the lettuce microgreens than in the mature form when treated with nitrate containing fertilizers.



Microgreens and sprouts differ by age at harvest. A typical 14-day germination period for a dicot, common garden bean, is provided as an example. Germination period for microgreens and sprouts varies by plant variety.

Table 1: 25 commercially grown microgreens

Common names	Family	Scientific name	Plant colour
Arugula	Brassicaceae	*Eruca sativa* Mill.	Green
Bull's blood beet	Chenopodiaceae	*Beta vulgaris* L.	Reddish-green
Celery	Apiaceae	*Apium graveolens* L.	Green
China rose radish	Brassicaceae	*Raphanus sativus* L.	Purplish green
Cilantro	Apiaceae	*Coriandrum sativum* L.	Green
Garnet amaranth	Amaranthaceae	*Amaranthus hypochondriacus* L.	Red
Golden pea tendrils	Fabaceae	*Pisum sativum* L.	Yellow
Green basil	Lamiaceae	*Ocimum basilicum* L.	Green
Green daikon radish	Brassicaceae	*Raphanus sativus* L. var. *longipinnatus*	Green
Magenta spinach	Chenopodiaceae	*Spinacia oleracea* L.	Red
Mizuna	Brassicaceae	*Brassica rapa* L. ssp. *nipposinica*	Green
Opal basil	Lamiaceae	*Ocimum basilicum* L.	Greenish-purple
Opal radish	Brassicaceae	*Raphanus sativus* L.	Greenish-purple
Pea tendrils	Fabaceae	*Pisum sativum* L.	Green
Peppercress	Brassicaceae	*Lepidium bonariense* L.	Green
Popcorn shoots	Poaceae	*Zea mays* L.	Yellow
Nutrient purple kohlrabi	Brassicaceae	*Brassica oleracea* L. var. *gongylodes*	Purplish-green
Purple mustard	Brassicaceae	*Brassica juncea* (L.) Czem	Purplish-green
Red beet	Chenopodiaceae	*Beta vulgaris* L.	Reddish-green
Red cabbage	Brassicaceae	*Brassica oleracea* L. var. *capitata*	Purplish-green
Red mustard	Brassicaceae	*Brassica juncea* (L.) Czem.	Purplish-green
Red orach	Chenopodiaceae	*Atriplex hortensis* L.	Red
Red sorrel	Polygonaceae	*Rumex acetosa* L.	Reddish-green
Sorrel	Polygonaceae	*Rumex acetosa* L.	Green
Wasabi	Brassicaceae	*Wasabia japonica* Matsum.	Green

Recent study of broccoli microgreen revealed that increase in blue light intensity could increase nutrient (carotenoids, tocopherols, glucosinolates, minerals) production in microgreens.

Microgreens are projected as 'super food' because of their high nutritional profiles. All the 25 commercially available microgreens (listed in Table 1) are high in almost every type of nutritional component such as vitamins, carotenoids, minerals, polyphenols and glucosinolates. On the other hand, total sugar content is much less in the microgreens than their matured counterparts.

Vitamins: Phylloquinone, also known as vitamin K1, is necessary for bone remodelling and blood coagulation. The 25 commercially available varieties of microgreens have a wide range of phylloquinone concentration ranging from 0.6 to 4.1 μg/g FW which is much greater than their mature forms. Ascorbic acid which is also known as vitamin C is generally measured in three forms i.e. total ascorbic acid (TAA), free ascorbic acid (FAA) and dehydroascorbic acid (DAA). All the three forms of ascorbic acid were recorded to be available at a higher concentration in all the 25 commercially available microgreens. The microgreens showed TAA concentrations that ranged from 20.4 to 147.0 mg/100g fresh weight.

Tocopherols and tocotrienols which belong to the vitamin E family have been recorded to be present at high concentrations in most microgreens. For example, green daikon radish has the greatest **α**-tocopherol (most active isomer form of tocopherol) and **γ**-tocopherol (most abundant isomer form of tocopherol) with 87.4 mg/100 g FW and 39.4 mg/100 g FW amongst the microgreens.

Carotenoids: **β**-carotene, the best known precursor of vitamin A, has been found in almost all the 25 microgreen varieties with red sorrel having the highest concentration at 12.1 mg/100 g FW.

Lutein and zeaxanthin the two major carotenoids present in blood stream and the only ones present in the retina and lens of the eye are recorded at high concentrations as well. Cilantro microgreens have the highest lutein/zeaxanthin concentrations at 10.1 mg/100 g FW. Violaxanthin is present in cilantro microgreens at very high concentrations (7.7 mg/100g FW).

Minerals: Mineral malnutrition is one of the most common problems facing human health in the developing countries. It is estimated that over 60% of the world population is iron deficient, 30% are zinc deficient and 15% are selenium deficient. Mineral contents of broccoli microgreen have been recorded to be much higher than mature broccoli. Compost-grown broccoli microgreens have been shown to have 1.15 to 2.32 times more minerals which include phosphorous (P), sodium (Na), potassium (K), zinc (Zn), magnesium (Mg), copper (Cu) manganese (Mn), iron (Fe), calcium (Ca) than mature broccoli.

Polyphenols and glucosinolates: Polyphenols and glucosinolates are a wide category of biologically active compounds. They have been associated with prevention of several chronic diseases such as Cardio Vascular Diseases (CVD), obesity and cancer. For example, microgreens of red cabbage have higher levels of polyphenols and glucosinolates than mature red cabbage.

Health Benefits of Microgreens

Prevention of obesity, CVD and diabetes: Quercetin, one of the most abundant flavonoids, induces apoptosis in preadipocytes. Other flavonoids such as rutin, resveratrol, naringenin, hesperidin have also been reported to inhibit preadipocyte proliferation. Hence, microgreens which contain high levels of flavonoids can regulate adipogenesis and thus can protect humans against obesity and related comorbidities including CVD and diabetes.

Modulation of gut microbiome and prevention of intestinal cancer: In recent years the importance of gut microbiome in sustaining gut health and preventing chronic diseases like cancer has come to light. Flavonoids are specifically important for the sustenance of gut microbiome. As microgreens are rich in flavonoids, they can regulate gut microbiome to help prevent chronic diseases such as intestinal cancers.

Regulation of epigenetic pathways: Diet-derived bioactive compounds have shown efficacy to regulate epigenetic pathways such as chromatin methylation, histone modification, etc. Brassica derived compounds such as phenethyl isothiocyanate (PEITC), sulforaphane, 13C and its acid dimerized derivative DIM have been reported to modulate histone methylation, promoter methylation and regulation of various miRNA. These effects on epigenetic pathways correlate with protection against some forms of cancer like prostate cancer.

Future Perspective

Microgreens are now been considered as a resilient phytochemical factory for dietary and psychological needs of crew members in orbital flights and platforms. Microgreens are very ideal for space flight environments because they can be implemented on static, shallow substrate with little to no nutrient which in turn alleviates the problem of poor crop performance related to low oxygen and nutrient solubility in microgravity hydroponic systems. The future of microgreens as a component of space life support system is thus an exciting new area of research.

Microgreens possess the capacity to alleviate global hunger. They can be cultivated with minimal use of supplementary nutritional elements such as fertilizers. Moreover, the harvesting time is less in microgreens without affecting the nutritional profiling of this class of vegetables which is very high when compared to the mature vegetables.

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