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A REVIEW ON OCCURRENCE, PROPERTIES AND FOOD SUPLLEMENT OF MICROGREENS IN HEALTHY DIET

Ranjitha Thirumalaisrinivasan*, Karthikeyan Krishnamoorthi, Shanmugam Palanisamy, Bharath Ganesan.

Department of Food Technology, K.S.Rangasamy College of Technology, Tiruchengode – 637 215, Namakkal, Tamil Nadu, India

ABSTRACT:

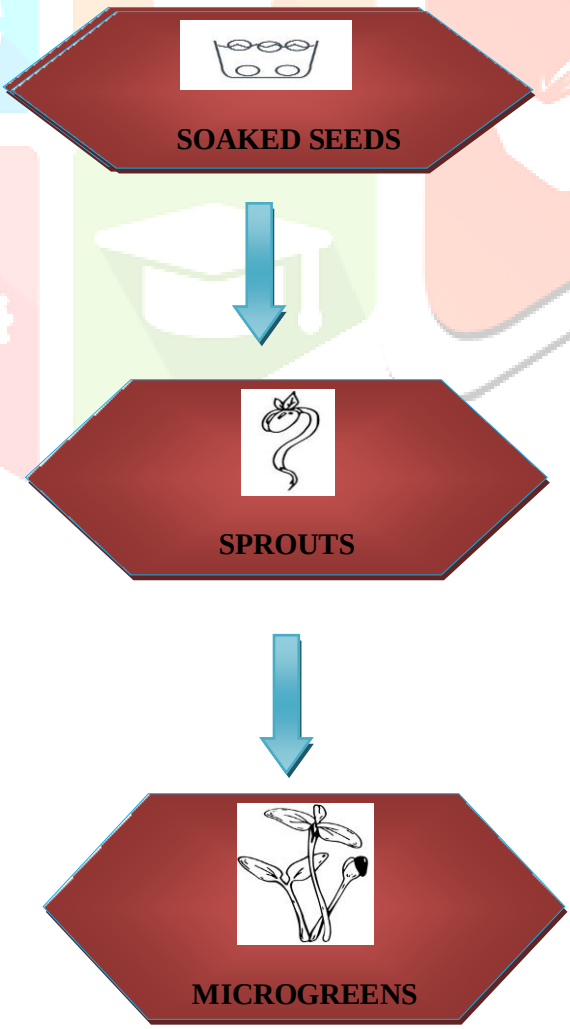
Microgreens, the young seedlings of edible vegetables and herbs, have gained significant attention in recent years due to their exceptional nutritional profile and potential health benefits. This review aims to provide a comprehensive overview of the occurrence, properties, and role of microgreens as a food supplement in a healthy diet. Microgreens are cultivated by harvesting the young shoots of various plants at an early growth stage, typically within 7-14 days after germination. They exhibit high concentrations of essential nutrients, including vitamins, minerals, and antioxidants, making them a valuable addition to a balanced diet. Additionally, microgreens showcase unique flavor profiles and vibrant colors, enhancing the visual appeal of dishes. Research suggests that regular consumption of microgreens can contribute to improved overall health and well-being. They have been linked to potential benefits such as reduced risk of chronic diseases, enhanced digestion, and improved immune function. The bioactive compounds present in microgreens, including phenolic compounds and carotenoids, exhibit antioxidant and anti-inflammatory properties, further supporting their health-promoting effects. Microgreens can be easily incorporated into daily meals as a versatile food supplement. They can be consumed fresh in salads, sandwiches, or smoothies, or used as garnishes and flavor enhancers in various culinary preparations. Their high nutritional content and potential health benefits make them an appealing choice for health-conscious individuals seeking to optimize their dietary intake. In conclusion, microgreens offer a promising addition to a healthy diet, providing a concentrated source of essential nutrients and bioactive compounds. Further research is warranted to explore their specific health effects and optimal consumption patterns. Encouraging the integration of microgreens into dietary guidelines may contribute to promoting public health and fostering a culture of nutritious eating habits.

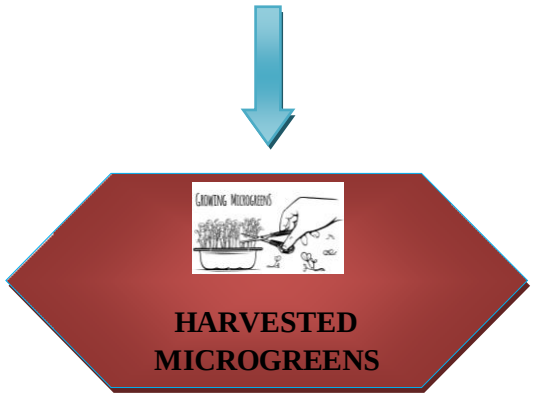
Keywords: Microgreens, seedlings, nutritional profile, health benefits, food supplement, antioxidants, culinary applications, dietary intake.

INTRODUCTION:

A pair of first real leaves may or may not have developed, but microgreens are fragile, immature greens with two completely developed cotyledon leaves. They typically grow to a height of 2.5-7.6 cm and are collected at this point. They are then eaten without their roots because they need light for growth. Microgreens are perfect for creating a desirable combination of taste, texture, and color because they have a considerably stronger taste and flavor than sprouts and consists of a wide range of leaves, diversity, and form [1]. Microgreens are called functional foods because of the substantial amount of bioactive chemicals they contain. They are providers of protein, fat, vitamins, and carbohydrates. They are considerably low in antinutrients and high in secondary metabolites like polyphenols, anthocyanins, carotenoids, and ascorbic acid when compared to mature plants. They also contain few antinutrients and are rich in amino acids and mineral salts (Ca, Mg, Fe, Mn, Zn, Se, and Mo) [2]. One of the important aspects of the environment for plants is the efficiency of the light. It impacts plant physiological and chemical processes by acting through distinct photoreceptors that are sensitive to different light wavelengths (phytochromes, cryptochromes, phototropins, and UVR8) [3]. The selection of the growing medium must undergo careful consideration because it is one of the most important aspects of the manufacturing process and could affect the output and quality of the microgreens [4]. It is important to assess the overall nutritional quality and contribution of the microgreens to the daily diet [5].

FLOWCHART FOR GERMINATION OF MICROGREENS [6]:





The flowchart appears to depict a process of growing and harvesting microgreens. The process starts with seed-soaked seeds, which are seeds that have been soaked in water to help initiate the germination process. These seeds are then planted and allowed to grow into sprouts, which are young plants that have just begun to emerge from their seeds. After the sprouts have grown to a certain size, they are harvested as microgreens. Microgreens are essentially the young seedlings of plants that are harvested when they are only a few inches tall. They are known for their delicate texture and strong flavor, and are often used in salads, sandwiches, and other dishes as a flavorful and nutritious garnish. The process of growing microgreens can take anywhere from a few days to a couple of weeks, depending on the variety of seeds being used and the environmental conditions in which they are grown. With proper care and attention, however, it is possible to produce a bountiful crop of fresh, flavorful microgreens that are sure to delight the palate and provide a range of health benefits as well.

DIFFERENCE BETWEEN MICROGREENS AND SPROUTS [7]:

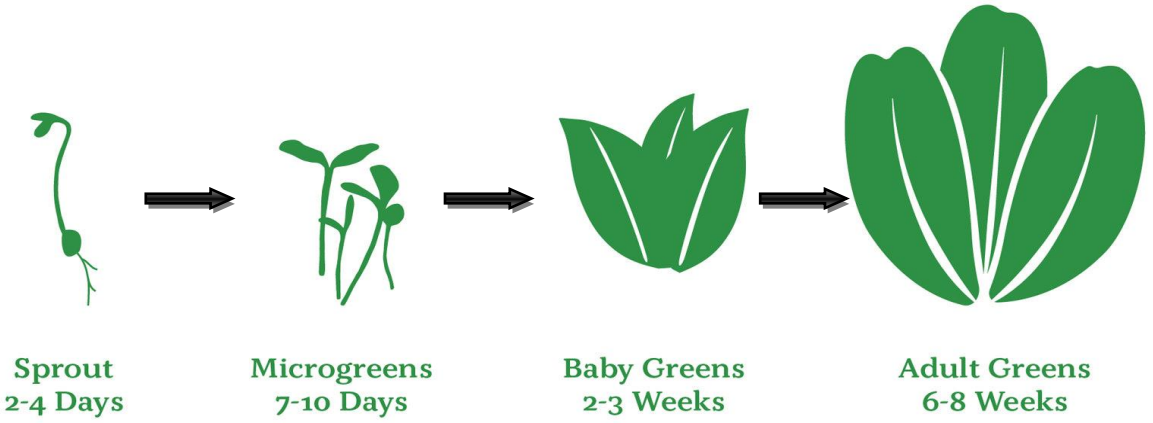
S.NO.	MICROGREENS	SPROUTS
1	Microgreens are collected from the soil's surface, so the roots are not consumed.	Sprouts are consumed with their roots intact and are made from seeds that have germinated or have partially germinated.
2	These greens require sunlight for their efficient growth and are grown in soil or other medium such as peat moss, vermiculite and perlite	The seeds are soaked in water in various time-temperature schedules, depending upon the type and size of seeds.
3	Seed density is low, as we have to eat the young greens which need space to grow.	Seed density is high in sprouts, this increases the water content in seeds and eventually germinates after the required time interval
4	They are grown in sunlight and harvested when baby leaves are emerged.	This is grown in high moisture, optimum temperature and low light conditions which increase the chances of microbial growth

SOME COMMERCIALLY GROWN MICROGREENS [8]:

SCIENTIFIC NAME				
S.NO	**COMMERCIAL NAME**	**FAMILY**	**GENUS AND SPECIES**	**PLANT COLOR**
1	Arugula	Brassicaceae	Eruca sativa Mill.	Green
2	Celery	Apiaceae	Apium graveolens L.	Green
3	Garnet amaranth	Amaranthaceae	Amaranthus hypochondriacus L.	Red
4	Golden pea tendrils	Fabaceae	Pisum sativum L.	Yellow
5	Magenta spinach	Chenopodiaceae	Spinacia oleracea L.	Red
6	Red cabbage	Brassicaceae	Brassica oleracea L. var. capitata.	Purplish green
7	Red mustard	Brassicaceae	Brassica juncea (L.) Czern.	Purplish green
8	Nutrient purple kohlrabi	Brassicaceae	Brassica oleracea L. var. gongylodes.	Purplish green

Arugula is a leafy green vegetable that belongs to the family Brassicaceae, which is also known as the mustard family. This family of plants includes a wide variety of species that are used for food, including kale, broccoli, cauliflower, and Brussels sprouts. The scientific name of arugula is Eruca sativa Mill., which is a species of flowering plant in the family Brassicaceae. It is also commonly known as rocket, roquette, or salad rocket, and is widely cultivated for its edible leaves. Arugula is known for its peppery, slightly bitter flavor, and is often used in salads, sandwiches, and other dishes as a flavorful and nutritious green. Arugula plants are typically characterized by their green, deeply lobed leaves and small white or yellow flowers that bloom in clusters. They are annual plants that are easy to grow, and are commonly found in gardens, farms, and markets around the world. Arugula is a rich source of vitamins, minerals, and antioxidants, and is believed to have a range of health benefits, including anti-inflammatory and anti-cancer properties.

GERMINATION OF MICROGREENS [17]:



Germination of microgreens is a simple and straightforward process that can be done by anyone with a few basic materials. Here are the general steps for germinating microgreens:

1. Choose your seeds: You can use any type of vegetable or herb seeds to grow microgreens. However, it is best to choose seeds that are specifically labeled for microgreens, as these will germinate quickly and produce the best quality greens.

2. Prepare your growing medium: Microgreens can be grown in soil or a hydroponic growing medium. If you are using soil, choose a high-quality potting mix that is free of contaminants and has good drainage. If you are using a hydroponic growing medium, follow the instructions for preparing it.

3. Plant the seeds: Spread a thin layer of seeds evenly over the surface of your growing medium. Make sure the seeds are not too crowded, as this can lead to poor growth and disease.

4. Water the seeds: Water the seeds gently using a spray bottle or watering can. Be careful not to overwater, as this can lead to fungal growth and other problems. Keep the soil moist, but not waterlogged.

5. Cover the seeds: Cover the seeds with a plastic lid or wrap to create a humid environment. This will help the seeds germinate quickly and grow strong.

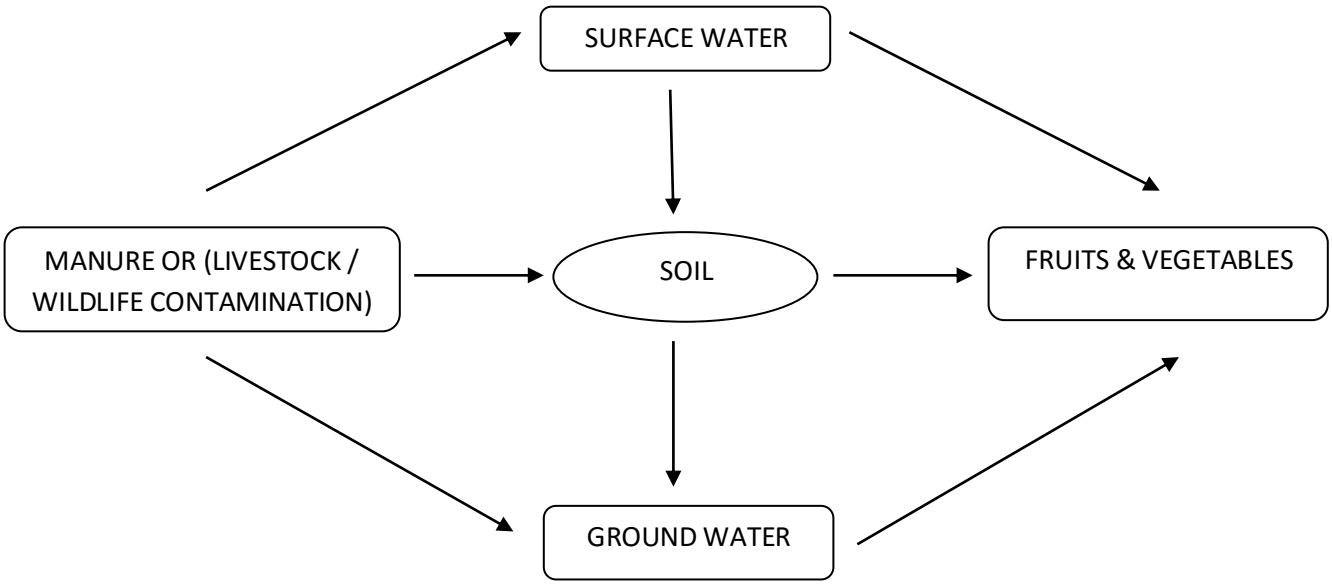
6. Keep the seeds in a warm place: Place the seeds in a warm spot with plenty of light. A sunny windowsill or under a grow light works well.

7. Check on the seeds: Check on the seeds daily and mist with water as needed to keep the soil moist. After a few days, the seeds will begin to sprout.

8. Remove the cover: Once the seeds have sprouted, remove the cover and continue to water and care for the microgreens as they grow.

9. Harvest: Depending on the type of microgreens, they can be harvested in as little as 1-2 weeks. Use scissors to cut the greens just above the soil line.

INTRODUCTION OF PATHOGENS INTO SOIL VIA MANURE/COMPOST APPLICATION [21]:



- Manure and compost are commonly used as soil amendments in agriculture and gardening to improve soil fertility and structure. However, if not managed properly, they can also introduce pathogens into the soil.

- Pathogens are microorganisms that can cause diseases in plants, animals, and humans. Some common pathogens found in manure and compost include bacteria such as E. coli, Salmonella, and Listeria, as well as viruses and parasites.

- When manure and compost are applied to soil, the pathogens can be introduced into the soil and potentially contaminate crops, water sources, and even humans and animals that come into contact with the soil or the crops grown in it.

LIGHT INFLUENCE IN MICROGREENS PHYSIOLOGY AND THEIR NUTRACEUTICAL QUALITY [9]:

One of the most important external factors which the photosynthetic organisms definitely require is light because it serves as a source of energy and environmental data. All oxygenic photosynthesis-dependent species require methods for balancing effective light gathering, photochemistry and UV protection from excessive light. In addition to affecting the rate of photosynthesis in plants, light intensity and quality also have an impact on the quantity and quality of different organic compounds that are produced, including secondary plant chemicals.

WASHING OF MICROGREENS [10]:

After harvest, microgreens can be washed to eliminate soil flecks and provide a clean product for packaging. Although washing greens before packaging lowers the initial bacterial load, it also generates a humid environment that encourages microbial development. As a result, excess water must be removed to prevent this growth. Since washing and dewatering involve additional handling that could harm the delicate greens and increase their susceptibility to microbial development, many producers opt to forgo washing them. After washing, it can be difficult to remove extra moisture without harming the fabric. In order to maintain temperature, moisture, and environment that maximise quality retention and shelf life of microgreens while inhibiting the growth of spoilage bacteria and human pathogens, a precise balance is necessary.

PROBLEMS RELATED TO STORAGE OF MICROGREENS [10]:

Microgreens have a high rate of respiration when harvested. Microgreens have a three to five-day shelf life at room temperature. Selling microgreens when they are still rooted in the growth media gives them the extended "shelf life". For excellent preservation, harvested microgreens must be refrigerated. Quality may be preserved for longer than 14 days depending on the variety and storage conditions. Although there are no regulations in the food code for microgreens, preliminary research indicates that they should be stored at 5 °C. In order to decrease respiration rates, stop moisture loss, lessen environmental contamination, and stop the growth of spoilage and pathogenic bacteria, an appropriate cold chain and acceptable modified atmosphere packaging (MAP) are necessary.

COMPARISON OF PHYROCHEMICAL CONCENTRATION OF SOME MICROGREENS AND ITS COUNTERPARTS:

A) CERTAIN PHYTOCHEMICAL CONCENTATIONS OF SOME BRASSICACEAE FAMILY MICROGREENS:

S. NO	NAME	PHYTOCHEMICALS						REFERENCE
		TOTAL ASCORBIC ACID	PHYLLOQUINONE	ß-CAROTENE	ANTHOCYANINS	GLUCORAPHANIN	GLUCOBRASSICIN	
1	Red cabbage	147.0 mg/100 g FW	2.8 µg/g FW	11.5 mg/100 g FW	12.44 µmol/g	4.80 µmol/g dry weight	1.15 µmol/g dry weight	[11,12,13]
2	Broccoli	-	-	-	-	0.67-0.85 µmol/g dry weight[a]	10.13-10.81 µmol/g dry weight[b]	[12,14]
3	Arugula	45.8 mg/100 g FW	1.6 µg/g FW	7.5 mg/100 g FW	-	-	-	[11]

a- Harvest day values, **b-** Combined values of 1-methoxyglucobrassicin and 4-hydroxyglucobrassicin on harvest day. FW = fresh weight. c USDA, Full Report (All Nutrients): 11959, Arugula, raw, National Nutrient Database for Standard Reference Legacy Release, April 2018; https://ndb.nal.usda.gov/ndb/foods/show/3569?n1=%7BQv%3D1%7D&fgcd=&man=&lfacet=&count=&max=&sort=&qlookup=&offset=&format=Full&new=&measureby=&Qv=1&ds=&qt=&qp=&qa=&qn=&q=&ing=.

B)CERTAIN PHYTOCHEMICAL CONCENTATIONS OF SOME BRASSICACEAE FAMILY MATURE (VEGETABLE) COUNTERPARTS:

S. NO	NAME	PHYTOCHEMICALS						REFERENCE
		TOTAL ASCORBIC ACID	PHYLLOQUINONE	ß-CAROTENE	ANTHOCYANINS	GLUCORAPHANIN	GLUCOBRASSICIN	
1	Red cabbage	24.4 mg/100 g FW	0.04 µg/g FW	0.044 mg/100 g FW	33.36 µmol/g	0.88 µmol/g dry weight	1.26 µmol/g dry weight	[11,12,13]
2	Broccoli	-	-	-	-	7.1±2.5 µmol/g dry weight[a]	1.1±0.4 µmol/g dry weight[b]	[12,14]
3	Arugula	15.0 mg/100 g FW	1.1 µg/g FW	1.4 mg/100 g FW	-	-	-	[11]

a- Harvest day values, **b-** Combined values of 1-methoxyglucobrassicin and 4-hydroxyglucobrassicin on harvest day. FW = fresh weight. c USDA, Full Report (All Nutrients): 11959, Arugula, raw, National Nutrient Database for Standard Reference Legacy Release, April 2018; https://ndb.nal.usda.gov/ndb/foods/show/3569?n1=%7BQv%3D1%7D&fgcd=&man=&lfacet=&count=&max=&sort=&qlookup=&offset=&format=Full&new=&measureby=&Qv=1&ds=&qt=&qp=&qa=&qn=&q=&ing=.

THE EFFECT OF LED LIGHT ON THE GROWTH OF SPROUTS AND MICROGREENS:……(OR) LIGHTING SYSTEM:

Photomorphogenic process, which is a default developmental process for the light-grown seedlings, is triggered by light in sprouts and microgreens during their development from seeds to edible vegetable products. Hypocotyls are one of the main edible parts of sprouts and microgreens, and the growth of hypocotyls could be affected by artificial lights. Fresh weight is one of the most important growth qualities of sprouts and microgreens. The effects of light on fresh weight varies depend upon the light spectra applied and varied among sprouts and microgreen species [6]. Microgreens were cultivated under custom-made lighting equipment containing separate modules for parallel growth runs under individually controlled illumination conditions. The LEDs were mounted on a flat aluminium heat sink with reflectors and were arranged to ensure optimal homogeneity of the flux. The LEDs were mounted on a flat aluminium heat sink with reflectors and were arranged to ensure optimal homogeneity of the flux. [18]. In addition to the visible spectrum of light, UV radiation (~200−400 nm) is also involved in the photo physiological processes of plants. Exposure to UV can stimulate metabolic responses involved in antioxidant system and photosynthetic pigment production, expression of genes in UV repair and protection, and accumulation of UV-absorbing and defense related phytochemicals (e.g., carotenoids and GSLs) [19].

RELATIVE HUMIDITY:

Relative humidity (RH) is another factor influencing quality and safety of fresh-cut produce. While dehydration primarily is detrimental to quality rather than safety of produce, excessive humidity is a problem for both produce quality and safety. Condensation of moisture on the commodity ("sweating") over long peiods of time stimulates microbial growth and decay more than a high RH of the ambient air alone [9].

HARVESTING OF MICROGREENS:

After the lighting experiment, microgreen cotyledons with stems were harvested just above the ground [3]. Microgreens are harvested when the desired height is attained and first set of cotyledon leaves and true leaves appear. These are ready for harvest when they reach the first true leaf stage, usually at about 5 cm tall and also depends on the type of crop. The time from seeding to harvest greatly varied for crops from 1 to 3 weeks. Harvested microgreens are highly perishable and are washed, cooled as quickly as possible using good handling practices for food safety [7]. Despite the short growing cycle, the commercial production of microgreens requires particular attention, and the choice of the growing medium represents one of the most critical aspects of the production process. The growing medium constitutes one of the main costs of production, and plays a major role in determining the yield and quality of microgreens, as well as the environmental sustainability of the production process. [20]

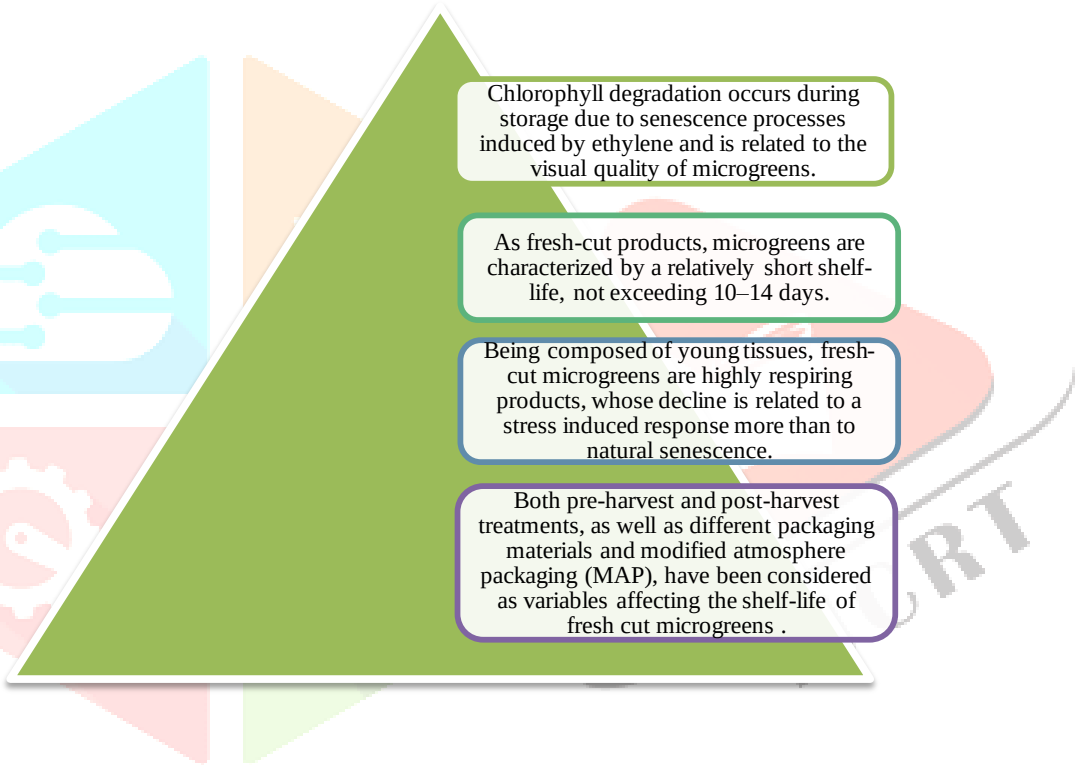
MICROBIAL SAFETY OF MICROGREENS:

Several postharvest factors may interact with microbial build up on microgreens including, proximity to the soil (i.e. plant height) at harvest, residual humidity following pre-packaging wash treatments, and storage temperature foremost. Sanitation remains a critical process for the establishment of ready-to-eat packaged 653 microgreens, and the expansion of industrial microgreens production [15].

CHALLENGES :

The growing demand for "superfoods" like microgreens can be a good opportunity for the Indian food industry. By creating special categories for greens, more people become aware of microgreens. Microgreens have a high price market and reliable customer segment (culinary and fancy restaurants) and, its high price market is a result of expensive production costs and challenges to keep them contamination-free during all stages, starting from media preparation to proper packaging. Contamination is no more a challenge because of modern technology, however that also amounts to its expense. On the other hand, microgreens low yield, rapid senescence, and very short shelf-life curbs the expansion of their commercial production [22,23,24].

MICROGREEN STORAGE [16]:



CONCLUSION:

Now a days the microgreens are gaining popularity in the market due to the change of lifestyle pattern and health consciousness among the consumers. Microgreens are gaining increasing recognition among consumers, acclaimed for their freshness and health promoting properties associated with densely fortified secondary metabolites. Generally the microgreens the high concentration of antioxidant, vitamins, minerals etc. Microgreens contain high levels of carotenoids, chlorophylls and organic acids but scarce amounts of sugars. They also show higher anti-diabetic and anti-cholinergic activity than sprouts. The microgreens are considered as "Functional foods". At present the microgreens are tried convert into ready to ready to eat products due to its health benefits. Consumption of sprouts and microgreens can be of magnificent importance for humans to stay healthy and avoid civilization diseases associated with oxidative stress. The future research will focus on the post harvest processing techniques and packaging technology to extend their shelf life.

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