Microgreens: A Nutrient Rich Crop that can Diversify Food System

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ABSTRACT
As the world’s population increasing at a rapid speed, food system must be revised to supply adequate nutrition while minimizing environmental impact. Current malnourishment statistics are high and affected large number of population. Thus, microgreens are new special category crop which are gaining popularity these days. They are tenuous cotyledonary leafy greens of many vegetables, spices and herbs that are found in variety of colours, textures and flavours, which are harvested at infancy stage. They belong to class of functional foods. They are dense source of many nutrients such as minerals, vitamins and antioxidants which are potential to prevent many diseases and deficiencies when consumed in small quantity. The nutritional values of microgreens are more quantitatively than mature ones. Microgreens can be easily cultivated and it takes minimum resource demands i.e. water, soil and pot or tray. Commonly grown microgreens are mustard, spinach, beetroot, lettuce, cilantro, cabbage, radish and broccoli. Microgreens production provide better access to adequate nutrition along with diversify food system. This review provides insight potential for microgreens to diversify food system.

Key words: Microgreens, Functional food, Cilantro, Cotyledonary, Food system

INTRODUCTION
Nowadays, functional foods and substantial interest for consumption of fruit and vegetable are in rising, compelled by growing interest of consumers for diets that support health and longevity. To feed the world’s rapidly growing population environmental sustainability of crop production has come into focus as problem-solving efforts work8. There is focus on production of fewer staple crops and thus the nutritional value of average diet reduced12,9 and there is a loss of nutrients when it comes from farm to plate. Therefore, simply upscaling current agricultural practices to increase crop yields is not an applicable solution for feeding the World’s population. It is a priority to establish dietary guidelines that satisfy human nutritional requirements with a diversity of foods that can be produced with minimized environmental impact26,25. Thus for accomplishing such advancements, there is a need to revising the food systems.
An estimated, two billion lives are affected in developed and developing countries by a chronic deficiency of essential minerals and vitamins (micronutrients), collectively known as hidden hunger. Current efforts to alleviate micronutrient deficiency are an emphasis on genetically engineering crops and biofortification methods of crops to overcome hidden hunger. However, microgreens are a new emerging crop that is a dense source of nutrients without biofortification and genetically engineering. Microgreens are a young seedling of edible vegetables, spices, herbs and grains including wild species. Microgreens are edible greens having two or more developed cotyledonal leaves. Depending on the species, microgreens are harvested at 7-14 days after germination with short crop cycle and usually with the average height of 2.5-7.6 centimetres. Microgreens are harvested at ground level including stem and cotyledons. Even in tiny size, microgreens can give a wide variety of intense flavour and it is known for its flavour that is spicy, nutty, sweet and sour etc. and colours. So microgreens can be used as a new ingredient in various dishes i.e. in salads, soups, dhal, chapatti and sandwiches etc. which help the dishes to enhance its texture, colour, flavour and also it gives diversity to food system. All microgreens demonstrated good to excellent consumer acceptance and overall acceptability of microgreens was strongly correlated to flavour acceptability. Microgreens should not be confused with sprouts, although both greens are consumed in an infantile stage. Sprouts are produced in wet and dark conditions whereas microgreens are produced in light condition and in soil media, so microgreens contain more nutrient and less microbial contamination than sprouts. Microgreens possess higher levels of vitamins, minerals, and other health-giving phytonutrients than the mature leaves. In this review, we will discuss production as well as the nutritional and biochemical composition of microgreens and their potential to diversify food system.

**Production of Microgreens**

Microgreens can be produced from a large number of vegetable, herb, and agronomic crops. The producer should evaluate various crop varieties to determine their value as microgreens. Microgreens are cultivated in a variety of environments specifically indoor, outdoor and controlled environment i.e. greenhouse and developing frameworks (growing systems) that is soil and soilless, depending on the scale of production. Containerized production, adaptable both to micro-scale urban and large-scale commercial operations, allow for commercialization of the product while growing on the media, to be harvested directly by the end user. This methodology bypasses harvesting and many postharvest handling issues and may guarantee freshness and high quality. Table 1 showing the commonly cultivated microgreens that are Spinach, Table beet, Mustard, Buckwheat, Arugula, bull’s blood beet, celery, cilantro, amaranth, golden pea, basil, spinach, mizuna, peppercress, popcorn shoots, red mustard, red beet, red cabbage, red orach, sorrel, red sorrel, wasabi, Cabbage, Broccoli, Radish, Lettuce.

**Table 1: showing commonly cultivated crops**

<table>
<thead>
<tr>
<th>Potential Microgreens Crops</th>
<th>Fennel</th>
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<tbody>
<tr>
<td>Amaranth</td>
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<tr>
<td>Arugula</td>
<td>Spinach</td>
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<tr>
<td>Table beet</td>
<td>Mustard</td>
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<tr>
<td>Buckwheat</td>
<td>Celery</td>
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<tr>
<td>Radish</td>
<td>Cilantro</td>
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<tr>
<td>Red cabbage</td>
<td>Broccoli</td>
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<tr>
<td>Lettuce</td>
<td>Carrot</td>
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</table>
Harvesting of microgreens at the right stage is one of the most important production strategies. The time period from cultivation to harvesting varies greatly from crop to crop. Some growers cultivate mixed crops of microgreens, thus growers should select the crops that are having similar growth rate so that whole crop can be harvested at once. Microgreens can be produced in the garden, pot, tray as well as container, depending upon requirements. Microgreens are harvested just above the soil line. Harvested microgreens are highly perishable and immediately washed, cooled as soon as possible using good handling practices for food safety. Microgreens are generally packed in polyethylene packages and cooled to recommended temperatures before supplying to the market or consumers.

### Bioactive Compounds

Utilization and consumption of microgreens have increased due to increased customer’s interest toward health and their awareness for health foods. High levels of functional compound have been found in microgreens due to which demand for it increased. Microgreens have been found to contain human bioactive compounds i.e. ascorbic acid, tocopherol, phylloquinone, phenolics, minerals and antioxidants more than mature one. A comparison study of mineral and nitrate content of microgreens and mature leaves of lettuce found that most of the minerals are high in the microgreens (Iron, Calcium, Magnesium, Zinc, Selenium and manganese) with low content of nitrate than mature one. So microgreens can be safely used as new ingredient as it is dense source of nutrients without exposure to harmful nitrate. Fenugreek microgreens and the mature fenugreek leaves were compared for sensory quality, phytochemical content and antioxidant activity when stored for 14 days at 10°C. The higher levels of ascorbic acid, total polyphenols and total chlorophyll obtained in fenugreek microgreens, which confirmed that phytochemical content tend to decrease with increasing maturity of the plant. Microgreens possess better retention of phytochemical compounds on storage. Fenugreek microgreens could be used both in the cooked and fresh form with good acceptability as indicated by the organoleptic evaluation.

Consumption of microgreens could be a health strategy to meet the mineral requirements as microgreens contain both micro and macro minerals. Microgreens are good source of iron & zinc i.e. 0.47-0.84mg/100g FW and 0.22-0.51mg/100g FW respectively (micro minerals) and calcium & potassium i.e. 28-66mg/100g FW & 176-387mg/100 FW respectively (macro minerals). Microgreens are grown from variety of crops such as radish, lettuce, mustard, cabbage, broccoli, amaranth etc. High concentration of ascorbic acid found in red cabbage 50 times more sulfurophane found in Broccoli microgreens by weight than mature broccoli. A total of 164 polyphenols including 30 anthocyanins, 105 flavonol glycosides and 29 hydroxycinnamic acid, and hydroxybenzoic acid were identified. The results showed that the Brassica species microgreens tended to have more complex polyphenol profiles and contain more varieties of polyphenols compared to mature plant counterparts. The protective effect against the oxidative stress shown by Brassicaceae (broccoli, Brussels sprouts, cabbage, kale, and cauliflower) is given by glucosinolates which are sulphur-containing glucosides. It was found that broccoli microgreens contain elevated levels of glucosinolates as compared to mature one. Proper dietary intake for space travellers with minimal resupply from the Earth, as food and food packaging currently represent a significant burden on space mission consumables. Usually traveller were suffered from weight loss, oxidative stress, increased muscle proteolysis, impairment of eye health and changes in the central nervous system. Microgreens are diminutive greens which provide abundance of vitamins, minerals, antioxidants, polyphenols with wide range of colour, flavour and crispness to the
food. Microgreens can act as an abundance of functional food as a component of space life support systems.

CONCLUSION
This study provides critical insights into the potential for various kinds of microgreens to provide a dense source of bioactive compound that can be grown with a small ecological footprint by individuals. Microgreens production could also diversify the average diet, as various crops contain wide range of nutrients which can be easily produce and consume by individual without much efforts. This review paper revealed that production of microgreens is a great addition to food system.

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