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Review Article

MICRO-GREENS TO OVERCOME THE PROBLEM OF MALNUTRITION DURING EMERGENCIES

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Abstract: Fruits and vegetables that are the source of nutritional diet are highly perishable. The supply of fresh food products to remote disaster-affected area country is a serious concern. Under such situations, microgreens can be helpful to diversify and enhance the nutrient content of the diet in remote locations where food with vitamins C and A availability is a common constraint. Microgreens are small, tender, and immature plants that typically have two fully developed cotyledon leaves, and may or may not have the emergence of a rudimentary pair of the first true leaves. These tiny plants are considered functional foods that are rich in phytonutrients, which offer numerous health-promoting benefits and antioxidant potential. Microgreens are a good alternative to high-value food against various disorders during emergencies. A review was undertaken to study the suitability of microgreens to combat malnutrition. In this review, we focus on the crops that are commonly utilized for microscale vegetable production, with a particular emphasis on the mustard family due to their abundance of health-promoting secondary metabolites, such as polyphenols and glucosinolates. Additionally, we explore the consumer acceptance of both sprouts and microgreens.

Keywords: *Microgreen, Emergency, Benefits, Media, Nutrients, Constraints*

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Introduction

Vegetables are considered to be a good source of a balanced diet as they are rich in dietary fiber, vitamins, photochemical, and minerals [1], highlighting the significance of vegetables for providing food and nutritional security. Low consumption of vegetables can lead to a vitamin and mineral-deficient diet. Chronic and acute diseases are caused as a result of metabolic disorders due to nutrient deficiency in the human body [2]. Mineral nutrients that are essential for a human being are best received from diet intake [3]. The dietary intake of these essential elements is necessary for the human health otherwise adverse effect due to the deficiency of these nutrients have been observed for various nutrients, e.g. deficiency of potassium and magnesium could cause osteoporosis and dwarfism in children [4], whereas the insufficient supply of iron leads to anemia which is a global issue and affecting the people of all ages [5].

An adequate supply of minerals through diet is essential for proper growth and sound health but mineral malnutrition has remained a global challenge for human nutrition [6]. Micronutrient deficiency in the diet has been described as "hidden hunger" [7,8]. Marked seasonal variations in diet availability and hidden hunger are prevalent in higher altitudes due to their general characteristics of limited agrarian resources, remoteness, and low level of market integration [9]. Microgreens are seedlings of vegetables, herbs, or even wild species that are grown to the stage of fully opened cotyledons and vary in flavor, color, and texture [10]. Microgreens belong to a special group of vegetables that are considered to be functional food possessing health-promoting and disease-prevention benefits in addition to their nutritional, vitamin, mineral, and antioxidant-rich value [11]. Microgreens are tender green immature tiny plants having two fully developed cotyledon leaves with or without the emergence of a rudimentary pair of the first true leaves, produced from the seeds of vegetables and herbs [12]. Microgreens have gained popularity due to their higher concentrations of bioactive compounds and mineral nutrients in comparison to mature plants. While there are roughly 100 plant species suitable for microgreen cultivation, the mustard family, including arugula, broccoli, cabbage, kale, and mustard, are the most commonly chosen due to their easy germination, short growing time, and diverse array of flavors and colors. Mustard family (Brassicaceae) microgreens play a significant role in promoting health due to their high concentrations of bioactive compounds such as ascorbic acid, carotenoids, tocopherols, and phenolic compounds, in addition to glucosinolates and mineral nutrients. Furthermore, their ability to thrive in a wide range of cultivation environments, from open fields to indoor environments, makes them appealing for individual households to grow on a small scale, as well as for commercial industries to grow on a larger scale. Indoor cultivation allows year-round-production of microgreens and the manipulation of light to improve plants' nutritional qualities [13-15].

Microgreens consumption has experienced a surge in popularity owing to their higher levels of bioactive compounds and mineral nutrients in comparison to mature plants. Furthermore, the nutritional value of microgreens can be further enhanced by selecting optimal lighting conditions during their cultivation. [16]. Various micronutrients serve as cofactors for numerous enzymes that are necessary for different metabolic processes and antioxidant activity, in addition to being essential for the immune system [17-19]. More than half of the world's population is malnourished because of the insufficient mineral nutrient content in their food [20].

The short growth cycle of nutrient-dense sprouts and microgreens allows for their production with minimal input, and without the use of pesticides, they can even be grown at home and harvested as needed. This not only results in low environmental impact but also broad acceptance among health-conscious consumers. [21].

According to the World Health Organization, malnutrition increases the risk of infectious diseases like diarrhoea, measles, malaria, and pneumonia, and chronic malnutrition can impair a young child's physical and mental development.

Need for microgreen

There are several reasons why microgreens are becoming increasingly popular:

1. Nutritional Benefits: Microgreens are packed with nutrients, including vitamins, minerals, and antioxidants, making them a great addition to a healthy diet. They can provide key nutrients in a practical way, and some people even consider them to be a superfood.
2. Easy to Grow: Microgreens can be grown easily at home with minimal supplies, making them a great source of daily nutritional requirements.
3. Faster Growth and Higher Yields: Microgreens take fewer days to produce more yields per unit area and time as compared to the growing of vegetables in the fields. Less time (83–85%) is required to produce a higher yield of radish microgreens than field-grown radish.
4. Food Security: Microgreens production could solve the problem of nutritional insecurity, especially in regions where fresh food is not readily available. For example, in remote locations with limited resources, microgreens can be grown easily, making them a continuous source of nutrition.
5. Sustainability: Microgreens can be grown using locally available materials, reducing the need for transportation and storage. Additionally, microgreens can be grown without the use of chemical inputs, making them a sustainable and organic food option.

Overall, microgreens are an easy, sustainable, and nutrient-dense food source that can contribute to a healthy and balanced diet. Phytonutrients are thousands in number and difficult to provide by artificially synthesized products. Therefore, to maintain an adequate level of nutrients in the body, there is a requirement for fresh vegetables and fruits in the human diet. Self-sufficiency in fresh food is a major concern in the Indian region leading to deficiency of Vitamin A, B6, B12, folic acid, and a few micronutrients [22]. A large segment of the population is experiencing varying degrees of nutrition as a result of socioeconomic backwardness and geophysical limitations [23]. Nevertheless, ensuring a consistent supply of conventional fresh vegetables and fruits in such areas is not practical. Therefore, the importance of microgreens cultivation is realized to provide fresh food with phytonutrients for army personas in harsh environments.

The nutrient compound of micro-green

With a delightfully earthy flavor, this microgreen is not only a culinary delight but also visually appealing. It boasts a plethora of nutrients, including 16% protein with high levels of lysine, as well as thiamine, niacin, calcium, potassium, iron, manganese, zinc, and copper. It is also a good source of vitamins A and C and folate.

Table-1 Essential minerals in microgreens of mustard family

Macro- and microelement in microgreen of Brassicaceae family	Content (mg 100 g^{-1})
K	176-387
Ca	52-86
Mg	28-66
Na	19-68
Fe	0.47-0.84
Zn	0.22-0.51
Mn	0.17-0.48

In order to cultivate microgreens, standardization of cultivation methods is crucial. While many commercial growers utilize soilless media in trays within greenhouses, hydroponic systems, such as the nutrient film technique, are also employed to produce microgreens.

Selection of seeds for micro-greens farming

Vegetable seeds like radish white, radish pink, cabbage, red cabbage, leafy cabbage, mustard, broccoli, beet root, and bunching fenugreek (Fenugreek) have been found suitable for microgreens farming. While some less palatable plants like peas and cucumber have been evaluated for microgreen cultivation.

Malnutrition and microgreens

Malnutrition can manifest in several ways and refers to deficiencies or excesses in nutrient intake, as well as an imbalance of essential nutrients or impaired nutrient utilization. It includes acute malnutrition, which occurs when a person does not get enough food to eat, leading to wasting or being too thin for their height. Chronic malnutrition, on the other hand, results in stunted growth or being too short for one's age. Both forms increase the risk of infectious diseases like diarrhea, measles, malaria, and pneumonia, with chronic malnutrition also impairing the physical and mental development of young children. Being overweight and obese can lead to diet-related non-communicable diseases such as heart disease, high blood pressure (hypertension), stroke, diabetes and cancer. Starvation can result in death. Additionally, an unbalanced or unhealthy diet can result in overweight and obesity, which is associated with consuming too many calories and often a lack of exercise. These conditions can also lead to diet-related non-communicable diseases, compounding the burden of malnutrition.

Natural Disasters and Nutrition

Natural disasters may not directly cause malnutrition, but they can lead to difficulties in accessing food due to disruptions in transportation and community infrastructure. This can put people at a higher risk of undernutrition and micronutrient deficiencies, especially those who were already malnourished before the disaster. Acute malnutrition can weaken the immune system and increase the risk of fatal diseases. Refugees and displaced people may face widespread undernutrition and micronutrient deficiencies due to limited access to adequate food and healthcare services. Inadequate nutrition and frequent infections during the first 1000 days of a child's life can lead to stunting, which can have irreversible long-term effects on their physical and mental development.

Fragile and conflict-affected countries were home to about 45% of the 156 million stunted children worldwide in 2015. Emergencies exacerbate the impact of non-communicable diseases in populations with high levels of such ailments, increasing the likelihood of illness and death. Among those affected, children are at the greatest risk of dying from starvation, as they become undernourished more quickly than adults. Severely wasted children are significantly more likely to die than their healthy-weight peers, as they are more susceptible to infections and their immune systems are compromised. In fact, undernutrition is an underlying factor in over 50% of child deaths from pneumonia and malaria, and over 40% of measles-related fatalities worldwide. Treatment for severe acute malnutrition must be immediate and comprehensive, involving medical, food, water and hygiene, and social services. Outpatient care is suitable for children with an appetite who need regular monitoring and specially-formulated foods, while inpatient care is necessary for those with medical problems and no appetite [24-26].

Microgreens vs sprouts

Underdeveloped leaves are produced by germinating sprouts in water instead of soil for a period of one or two days while microgreens grow in soil and sunlight and take at least a week to produce leaves.

Microgreens benefits

Microgreens, despite their size, are known to have a stronger flavor compared to their larger counterparts. For instance, red cabbage microgreens contain 40 times more vitamin E and 6 times more vitamin C, while cilantro microgreens have three times more beta-carotene. According to the study, among the microgreens evaluated, red cabbage had the highest concentration of vitamin C, cilantro had the highest concentration of carotenoids, garnet amaranth had the highest concentration of phylloquinone, and green daikon radish had the highest concentrations of tocopherols. However, due to their cost and the amount needed to consume to be considered a substitute for regular vegetables, microgreens are not typically viewed as a replacement for larger vegetables.

How to grow microgreens

Growing microgreens is an easy and affordable way to add nutrition and flavor to your meals. Even though microgreens can be expensive in grocery stores, they can be grown in your own kitchen or garden with just a few simple supplies: light, soil, water, and seeds. Seed mixes with similar flavor profiles can be found in stores or online. Before planting, be sure to check if the seeds need to be pre-soaked in water, as larger seeds like kale and pea may require this step.

Medium-sized seeds like arugula, basil, and mustard, and small seeds like oregano, thyme, mint, tarragon, and sage can be planted without pre-soaking.

Growing microgreens outdoors

If you're growing microgreens indoors, fill a shallow container with soil, leaving about an inch of space at the top. Scatter the seeds evenly across the soil, making sure they are not too crowded. Press them gently into the soil and cover them with a thin layer of soil. Use a spray bottle to mist the seeds and soil until it is damp but not soaking wet.

Once the seeds are planted and watered, place the container in a location that receives plenty of natural light. South-facing windowsills are great for this, or you can use artificial grow lights. Keep the soil moist by misting it with water every day or every other day, depending on the humidity in your home.

After about a week, the sprouting of seeds should be initiated. As the microgreens grow, it should be ensured that the soil is kept moist and they are continuously provided with ample light. Once the desired height, usually about 1-2 inches, has been reached by the microgreens, they are ready to be harvested. They can be simply cut with a sharp pair of scissors, rinsed off, and utilized

Growing microgreens indoors

If planting your microgreens indoors, a small container filled with a few inches of organic potting mix should be used. For this purpose, plastic containers, such as those used for fruit like blueberries or strawberries, are suitable. Clamshell takeout containers and aluminum pie trays also work, provided that holes are poked in the bottom for water drainage. To avoid the potting mix from leaking out, a damp paper towel should be placed at the bottom before adding the potting mix.

Scatter the seeds ¼-inch apart and press them gently into the soil, using the same technique as for outdoor microgreens. Cover the seeds with ⅛ inch of potting mix and moisten the soil until it feels like a sponge.

To encourage germination, some growers suggest covering the microgreens with plastic wrap. Place the microgreens in a location with at least four hours of sunlight per day, such as a south-side windowsill or another area in your home.

When to harvest microgreens

The soil should be moistened as needed, and overwatering should be avoided. Harvesting of the microgreens can be done in 10 to 14 days once the true leaves emerge, and they should be cut slightly above the soil with scissors. Unfortunately, the microgreens cannot regrow after the initial harvest and new seeds and soil will be required for further growth.

Microgreen kits are also available for those seeking an easier growing solution. These kits typically include seed packets, compostable grow trays, soil discs, and tray covers, with watering being the only daily task until the desired length is reached. Large retailers like Lowe's and Home Depot now offer microgreen kits for sale. Pea shoots are one of the healthiest microgreens and are included in the Seasonal microgreens Seed Club from time to time due to their beta-carotene content, which is converted by the body into vitamin A, vitamin C, folate, and fiber, all essential for building the human body.

The safety of consuming microgreens is generally accepted, with a lower risk of bacterial growth compared to sprouts. Microgreens are considered functional food and are often referred to as superfoods due to their high nutrient content, including fiber and vitamin K, which can aid in managing high blood pressure and reducing the risk of heart attacks. While it may be tempting to try and regrow microgreens after harvesting, most varieties won't regrow, and starting over with fresh seeds is recommended. Water-soluble vitamins found in microgreens enhance enzyme activity in the body, aiding in nutrient absorption.

Constraints in microgreens

The microgreens with high levels of phytic acid, such as rockets, may display lower iron uptake from food compared to mature forms. Consuming microgreens contaminated with harmful bacteria can lead to sickness within a few days, with symptoms ranging from immediate reactions to delayed onset up to six weeks. While severe cases can occur, chronic or life-threatening health problems are unlikely.

Benefits of growing microgreens during a disaster

During disaster water scarcity affects the domestic water supply and irrigation, which ultimately affects vegetable production in the region as the water requirement for the vegetable crop is higher than field crops and cannot tolerate drought conditions. Being succulent, vegetable crops are more sensitive to drought stress during the flowering to seed development stage

The water requirement for growing microgreens is very less as broccoli microgreens require 158–236 times less water than growing the nutritionally equivalent amount of broccoli vegetables in field conditions. The field-grown radish use 7–8 times higher water as compared to radish microgreens. Therefore, growing microgreens vegetables during an emergency is a good strategy to yield an equal amount of nutrition to field-grown vegetables under scarce water resource conditions.

Media for microgreen

Microgreens can be grown commercially on peat media or other locally available material which could be a solution under poor soil. The microgreen can be grown using locally available materials such as sawdust and vermicompost. It's also promising that microgreens farming can be done without the use of chemical inputs, making it an organic option. The fact that microgreens can be grown in remote locations and harsh areas can provide a sustainable source of fresh produce to communities that may have limited access to it. Additionally, the shorter time required to grow microgreens compared to field-grown vegetables could potentially increase food production and contribute to food security. Food security according to World Food Summit-1996 comprises the dimension of availability of, access to, and utilization of food, described as food security when all people at all the time have economic and physical access to nutritious, safe, and sufficient food to meet dietary needs and preferences of food for health a and active life. Self-sufficiency in food does not always mean food security for everyone.

Conclusion

Microgreens can be grown commercially using locally available materials such as coco peat, vermiculite, perlite, and even sawdust and vermicompost. Compared to field-grown vegetables, microgreens require less time, less water, and less area to produce higher yields per unit area. Microgreen farming can also be a means of organic vegetable production, which can provide nutritious and safe food for people in remote areas where access to fresh food is limited. Microgreens are rich in nutrients, and their consumption could help solve the problem of nutritional insecurity. As natural resources decrease and the climate changes, microgreen production can be an excellent adaptive approach to fill the consumers' plates with nutrition.

Application of research: Study of micro-greens to overcome the problem of malnutrition during emergencies

Research Category: Malnutrition and microgreens

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