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Nutritional Quality Analysis of Green Gram Microgreens Grown in Different Media

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ABSTRACT: Microgreens are immature vegetable greens harvested after the emergence of cotyledonary leaves. They are characterized by a wide variety of colours, flavours and textures. Microgreens show interesting nutritional properties and have been referred to as "super foods". For the study, high yielding variety seeds of green gram were selected and grown in different media. The green gram microgreens grown in soil had the highest nutritional value when compared with the microgreens grown in other media. The Calcium and Vitamin C content of green gram microgreens grown in soil was found to be 30.42mg and 27.01mg respectively. The dietary fibre content of green gram microgreen grown in soil was observed to be 2.14g. Appropriate pre- and post-harvest strategies may allow microgreens to retain their nutritional value as long as possible. There is limited literature on microgreens grown in different media. Hence this study was taken up to analyse the nutritional quality of green gram microgreens grown in different media.

Keywords: Microgreens, Green gram, Super Foods.

INTRODUCTION

Consumption of fruits and vegetables is an effective way to maintain and improve human health. The bioactive phytochemicals present in the fruits and vegetables helps to lower the incidence of chronic diseases and other related health benefits (Saini *et al*., 2017). As the world's urban population grows, there is need for a reliable, easily accessible, and nutritionally dense food supply. With the increasing focus of society on healthy eating, there is a demand for fresh, ready-to-eat, functional food, such as micro scale vegetables like sprouted seeds and microgreens (Ebert, 2022).

Microgreens are the young and tender vegetable greens, obtained from the seeds of numerous species. They are harvested a few days or weeks after germination or when the cotyledons are fully developed and the first true leaves have emerged (Treadwell *et al*., 2020). During the harvest, plant height may vary from 2.5 to 8 cm depending on the species (Bulgari *et al*., 2021). Microgreens are also known as vegetable confetti or mini-greens. They are cultivated by using edible seeds of different plants and their harvesting time varies according to the specific species of microgreens being grown (Turner *et al*., 2020).

Microgreens have higher concentrations of phytonutrients and secondary metabolites, such as amino acids, enzymes, pigments, vitamins, polyphenols, and antioxidants, than their mature plant counterparts promoting them as a healthy addition to the diet (Nair and Lekshmi 2019; Verlinden, 2020). They claimed to be nutritionally beneficial and often associated with the terms 'nutraceutical' and 'functional food' (Samuolienė *et al*., 2017). According to Paradiso and co-workers (2018) microgreens have gained increasing attention in the last decade as a new culinary specialty.

Microgreens are smaller than the baby greens and are harvested later than the sprouts. The major difference among sprouts, baby greens and microgreens is the harvest time. Baby greens are generally harvested at 2 to 4 inches for 15 to 40 days, whereas microgreens are harvested right after the appearance of true leaves (Choe *et al*., 2018). Microgreens can be considered as better substitutes for sprouts due to their rich nutritional content and more intense flavour and taste (Puccinelli *et al*., 2019).

An interesting aspect to consider is the connection between microgreens and sustainability. Microgreens have fast growth cycles, can be grown efficiently in small spaces, and require fewer resources compared to traditional agriculture. The public and private sectors are showing significant interest in urban farming, particularly in controlled environment farming (Lone *et al*., 2024). As microgreens come under the soilless system of cultivation, it is an ideal approach for enhancing the nutrient content of diets. Its cultivation allows for meticulous regulation of plant growth parameters, enabling the adjustment of specific nutrient levels to enhance human health (Renna *et al*, 2022).

The future of microgreens looks promising as they will gain traction in urban agriculture and culinary spaces. As culinary innovation continues, microgreens are likely to become a staple food in both everyday meals and gourmet dishes, reflecting their versatile and valuable role in modern diets. Microgreens generally have a short shelf life due to their rapid wilting and deterioration (Mir *et al*., 2017). This perishability may impede the further market growth and export of the crop (Berba and Uchanski 2012). But recent market studies have revealed that the global microgreens market is anticipated to rise at a considerable rate during the forecast period, between 2024 and 2031.

There are more than 25 microgreens commercially grown all over the world (Kumar *et al*., 2016). Commonly grown microgreens are mustard, fennel, fenugreek, radish, buckwheat, lettuce, spinach, etc. This study was conducted to evaluate the nutritional quality of microgreens grown in different media. For this study, the microgreen variety used was green gram.

MATERIALS AND METHODS

For cultivating microgreens, high yielding variety of green gram seeds were procured. Plastic trays with perforations were used to enable proper drainage. The media (m) used for cultivation were:

- m_0 - Control
- m_1 - Tissue paper
- m_2 - Cocopeat
- m_3 - Cocopeat with soil
- m_4 - Soil
- m_5 – Burlap

The seeds were soaked in water for 8-10 hours before broadcasting into the trays. The trays were filled with two inches of medium and then seeds were manually broadcast. Water was sprinkled using a sprayer twice a day, to keep the surface moist. Germination was observed from the second day and on the consecutive days sprouts were formed. On the 9th day the microgreens were ready to be harvested, after the appearance of the first leaves. Fig. 1 shows the green gram microgreens grown on different media, just before harvesting.

The harvested greens were then subjected to nutrient analysis. The values of Moisture (%), Tannins (mg per 100g), Polyphenols (mg per 100g), Flavanoids (mg per 100g), Fibre (g per 100g), Calcium (mg), Iron (mg), β-carotene (μg), Vitamin C (mg) and Total minerals (g) were ascertained. The procedures adopted for analyses were as detailed below.

Nutrient	Method
Moisture	AOAC Method (1990)
Tannins	Sadasivam and Manickam (1992)
Polyphenols	Sadasivam and Manickam (1992)
Flavonoids	Sadasivam and Manickam (1992)
Fibre	AACC Method (2000)
Calcium	Titration Method with EDTA by Hesse (1971)
Iron	Atomic Absorption Spectrophotometric Method by Page *et al.* (1992)
β-carotene	Sadasivam and Manickam (1992)
Vitamin C	Sadasivam and Manickam (1992)
Total minerals	Sadasivam and Manickam (1992)

Statistical test like ANOVA was used to compare the difference in mean values using KAUGRAPES (online statistical analysis tool).

Fig. 1. Green gram microgreens grown in different media.

RESULTS AND DISCUSSION

The green gram microgreens grown in m_4 were found to have the highest moisture content of 88.23 % which was on par with the values of moisture content of m_3 as shown in Table 1. The lowest moisture content was observed in m_0. The CD was found to be 0.019. Since the p-value in ANOVA table is < 0.05, there is a significant difference between the treatments. Physicochemical properties of buckwheat microgreens grown under different conditions had shown difference in their moisture content (Choi *et al*., 2015). Microgreens contain higher amount of moisture in contrast of low amount of carbohydrates and fat, and protects the human body from weight gain and type 2 diabetes (Bhaswant *et al*., 2023).

Table 1: Phytochemical composition of Green Gram Microgreens

Treatment	Moisture	Tannins	Polyphenols	Flavonoids	Fibre
m_0	86.62	1.08	0.23	1.61	1.73
m_1	87.54	1.19	0.31	1.74	1.79
m_2	87.63	1.34	0.37	1.90	1.84
m_3	88.04	1.41	0.42	1.91	1.91
m_4	88.23	1.48	0.46	1.99	2.14
m_5	87.17	1.12	0.28	1.68	1.74
CD	0.019	0.018	0.018	0.018	0.018

The highest tannin content was also observed in m_4. The value as found be 1.48mg. The lowest value was observed in m_0 (1.08 mg). There was a significant difference in the treatments, as the CD is found to be 0.018 as given in Table 1.Sangronis and Machado (2007) observed that there was 14.3% reduction in tannins in germinated pigeon beans, 19% in black beans and 36.2% in white beans. According to Kalpanadevi and Mohan (2013) germination process is considered to be one of the reasons for reduced tannins in *Vigna unguiculata* (L.) Walp. subsp. *Unguiculata*. Tannins are a significant class of dietary polyphenols with a number of proven health benefits. because of their poor stability, sensory qualities, and bioavailability, tannins have very limited applications, despite being widely used in food, pharmaceuticals, and numerous other sectors. (Zeng *et al*., 2022). Various studies have revealed that microgreens are good sources of polyphenols. In this study, it was observed that the highest polyphenol content was found in m_4 (0.46mg) which was on par with m_3 (0.42 mg). Table 1 shows that the lowest polyphenol was 0.23 mg seen in m_0. Significant difference ($p < 0.05\%$) was seen between the polyphenol content of the green gram microgreens. Peak contents of polyphenols were observed in the second week after germination in microgreens (Niroula *et al*., 2021). Sun and co-workers (2013) conducted a comparative study in five Brassica species and the results showed that microgreens contain more variety of complex polyphenols than mature plants, thus proving that microgreens are an important source of bioactive substances.

The highest flavonoid content was found in m_4 (1.99 mg). It was also found that m_3 and m_2 had approximately same values for flavonoid content *i.e.*, 1.91mg and 1.90 mg respectively. There was a significant difference ($p < 0.05\%$) in the flavonoid content of green gram microgreens.Studies by Lobiuc and co-workers (2017) report that variations in total flavonoid (TF) content ranged from 1.1 to 6.5 mg/100 g in microgreens. Roselle microgreens had the highest TF content, followed by sunflower and fennel microgreens. Least TF content was recorded in mustard microgreens. The content of flavonoids in the plant depends significantly on the species and the environmental conditions in which the plant thrives (Gavriš *et al*., 2018). The dietary fibre content of green gram microgreen grown in m_4 was observed to be 2.14g. The lowest fibre content was found to be 1.73g in m_0. Significant difference ($p < 0.05\%$) was observed between the treatments. According to Ghoora and co-workers (2020) the concentration of dietary fibre increases in the sequence: raw seeds-sprouted seeds-microgreens. The fibre content in microgreens ranged from 1.4 to 4.3 g 100 g^{-1}. Microgreens, as a novel food, have shown an increase in their acceptability and popularity in the urban markets, due to their high nutrient density and potential health benefits (Zhang *et al*., 2021).

Microgreens are rich in vitamins (e.g., vitamin C), minerals (e.g., copper and zinc), and phytochemicals, including carotenoids, which act as antioxidants in the human body. The presence of numerous nutritional factors enable microgreens to act as functional foods. The calcium content of green gram microgreens grown in m_4 was found to be the highest (30.42mg). The lowest calcium content was seen in m_0 (29.91mg). The results emphasize that there were significant differences ($p< 0.05\%$) in the calcium content of green gram microgreens. Microgreens are seen to be good sources of Calcium (28–66 mg/100 g). Consumption of microgreens could be considered as a health-promoting strategy to meet dietary requirements of essential elements beneficial to human health (Xiao *et al*., 2016). From the study it was observed that the microgreens grown in m_4 had the highest iron content (1.33mg). The lowest iron content was found in microgreens grown in m_0 (0.78mg) as seen in Table 2. As revealed in Table 2, there was a significant difference in the iron content of the green gram microgreens ($p < 0.05\%$). Microgreens had higher content of Fe than mature leaves. Thus they can be considered as a good sources of iron. Microgreens may also contain higher quantities of promoters of iron absorption such as ascorbic acid. About 25 commercially available microgreens of different vegetables were generally found to have higher levels of vitamins and carotenoids, than their mature plant counterparts (Khoja *et al.*, 2020). Pinto and co-workers (2015) compared mineral profile of microgreens and mature lettuces and the result indicated that microgreens possess a higher content of most minerals such as Ca and Fe than mature lettuces.

Table 2: Nutritional Composition of Green Gram Microgreens

Treatment	Calcium	Iron	Vitamin C	β-Carotene	Total Minerals
m_0	29.91	0.78	25.30	0.73	0.18
m_1	30.29	0.85	24.63	0.85	0.22
m_2	30.33	0.94	25.58	0.94	0.29
m_3	30.36	1.18	26.26	1.02	0.31
m_4	30.42	1.33	27.01	1.13	0.33
m_5	30.25	0.88	24.86	0.89	0.26
CD	0.018	0.018	0.018	0.018	0.019

Vitamin C, also known as ascorbic acid, is a potent antioxidant and is essential for a variety of biological functions (Chambial *et al.*, 2013). The highest amount of Vitamin C was found in m_4 (27.01mg). The lowest vitamin C was found in m_1 (24.63 mg) as shown in Fig. 2. Significant difference ($p < 0.05\%$) was seen between the Vitamin C content of green gram microgreens. Microgreens are good sources of nutrients like Vitamin C. The Vitamin C content in 10 commercially available microgreens ranged from 29.9–123.2 mg/100 g FW (Khosravi and Asadollahzadeh 2014). Xiao *et al.* (2012) reported the range of total Vitamin C content (20.4–147.0 mg/100g FW) in 25 commercially available microgreens and claimed that many had higher total Vitamin C concentration than their mature plants (Yadav *et al*., 2019). A study by Treftz (2015) found that there was a significantly higher ascorbic acid content in soil grown raspberries yet lower in soil grown strawberries, compared with their hydroponically grown counterparts.

The highest β-carotene content was found in green gram microgreens grown in m_4 (1.13 µg). The lowest β-carotene content was seen in m_0 (0.73 µg) (Table 2). According to Xiao *et al*. (2012) the β-carotene, concentrations of microgreens ranged from 0.6 to 12.1µg. There was a significant difference ($p < 0.05\%$) in the β-carotene content of green gram microgreens. A study conducted by Kowitcharoen *et al*. (2021) revealed that the lentil microgreens had the highest carotenoid (28.37µg 100 g^{-1}) contents among various microgreen varieties. Niroula *et al*. (2021) studied the carotenoid profile of wheat (*Triticum aestivum* L.) and barley (*Hordeumvulgare* L.) microgreen and found that the carotenoid content in the microgreen phase was higher than that in the seed phase. The microgreens grown in m_4 had the highest total mineral content (0.33g), whereas the lowest was observed in m_0 (0.18g). Significant difference ($p < 0.05\%$) was observed in the total mineral content of the green gram microgreens. According to Weber (2017) higher amount of minerals was obtained in broccoli microgreens, compared to the mature vegetable. Microgreens are great sources of minerals like Ca, Fe, Cu, Zn, K etc.

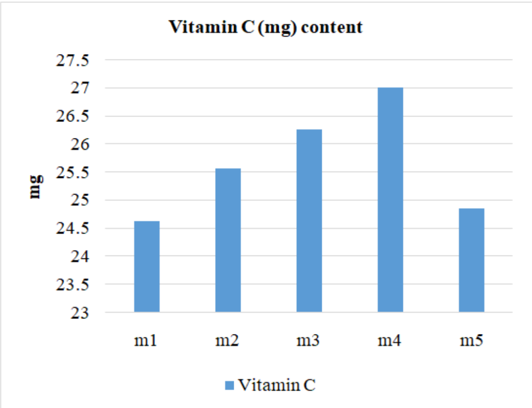

Fig. 2. Vitamin C content of Green gram microgreens grown in different media.

Considering the fact that the nutrient potential of microgreens when compared to their mature counterparts have the possibility to delineate genotype-specific nutritional profiles. They could be a precious resource for developing tailored microgreens, with the desired nutritional features.

CONCLUSIONS

Microgreens are considered as the new emerging functional foods of the century (D'Imperio *et al*., 2024). They are the young and tender vegetables, obtained from the seeds of various plant species. The nutritional properties of microgreens make them very popular among consumers. Based on the results, it was observed that the green gram microgreens grown in m_4 (soil) (Fig. 3) had the highest nutritional value when compared with the microgreens grown in other media. This indicates that soil is the most suitable medium to supply nutrients for obtaining quality microgreens from green gram. According to Eswaranpillai and co workers (2023) soil was found to perform the best in terms of microgreens' nutritional value since it has the highest concentration of nutrients of any other media. Deepa and Malladadavar (2020) recommends the traditional soil cultivation for microgreens for individual growers.

Fig. 3. Green gram microgreens grown in m_4 (Soil).

FUTURE SCOPE

Microgreens have gained significant popularity in recent years due to their high nutritional value, unique flavours, and visual appeal. While they are primarily cultivated for culinary purposes, there is also a considerable scope for research and innovation in the field of microgreens. Here are some areas where future research could focus on:(a) With the increasing popularity of urban farming, there is potential for research into methods for growing microgreens in small-scale urban environments, such as vertical farms, hydroponic systems, or indoor gardens. (b)Exploring new ways to incorporate microgreens into food products could open up opportunities for value-added products in the food industry. By addressing these research areas, we can unlock the full potential of microgreens as a nutritious, flavourful, and sustainable food source.

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Conflict of Interest. None.

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