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Sustainable Household-Scale Cultivation and Nutritional Profiling of Sunflower Microgreens

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Abstract

Background: Microgreens are increasingly investigated as nutrient-dense plant foods that may contribute to dietary diversification. However, the nutritional composition of sunflower (*Helianthus annuus* L.) microgreens under simple household-scale cultivation conditions remains comparatively under-characterized.

Objective: The present study evaluated the proximate composition, mineral profile, antioxidant constituents, antioxidant activity, and selected antinutritional factors of sunflower microgreens cultivated under household-scale conditions.

Methods: Untreated sunflower seeds were cultivated in cocopeat-filled geo-fabric grow bags under natural indirect sunlight and ambient conditions without nutrient supplementation. Microgreens were harvested at the early true-leaf stage (7-10 days after sowing). Proximate composition was determined using AOAC methods, while minerals, vitamins, phytochemicals, antioxidant activity, oxalate, and phytate were estimated using standardized analytical procedures. All determinations were conducted in triplicate and expressed as mean ± standard deviation.

Results: Fresh sunflower microgreens contained 80.78 ± 0.03 g/100 g moisture, 4.08 ± 0.02 g/100 g protein, 6.26 ± 0.06 g/100 g carbohydrate, and 2.93 ± 0.04 g/100 g crude fibre. Among the minerals analysed, iron was 15.63 ± 0.12 mg/100 g, calcium 44.67 ± 0.12 mg/100 g, while β-carotene and total flavonoid content were 300 ± 0.10 µg/100 g and 216.70 ± 0.10 mg RE/100 g, respectively. DPPH radical scavenging activity was 81.51 ± 0.02% inhibition. Oxalate and phytate contents were 22.32 ± 0.01 and 0.36 ± 0.02 mg/100 g, respectively.

Conclusion: Sunflower microgreens cultivated under the household-scale conditions evaluated in this study exhibited a measurable profile of protein, fibre, minerals, vitamins, and antioxidant-related constituents, together with quantified levels of selected antinutritional factors. These findings provide baseline compositional data for sunflower microgreens produced using a simple, low-input cultivation approach and may inform further investigation of their dietary and food-application potential.

Keywords: Sunflower Microgreens, Nutritional Profiling, Household-scale Cultivation

1. INTRODUCTION

Micronutrient Deficiencies and Dietary Diversification

Contemporary nutrition research recognizes that achieving food security requires not only adequate food availability but also diets of sufficient nutritional quality to meet essential micronutrient requirements.
Despite substantial improvements in agricultural productivity, micronutrient deficiencies remain prevalent

because many populations continue to consume diets with limited diversity and inadequate intake of nutrient-rich foods [1][2]. Consequently, food-based dietary diversification has gained increasing recognition as a sustainable strategy for improving micronutrient adequacy by encouraging greater consumption of naturally nutrient-dense foods within habitual diets [2]. In this context, there is growing scientific interest in identifying edible plant foods with high nutritional value that may contribute to dietary diversity patterns.

Microgreens as Nutrient-Dense Foods

Among such nutrient dense foods, microgreens have emerged as a distinct category of young edible seedlings harvested between the cotyledonary stage and the emergence of the first true leaves [3][4]. Owing to their short growth cycle, ease of cultivation, and high concentrations of vitamins, minerals and diverse bioactive phytochemicals, microgreens have attracted considerable interest as functional foods with potential to enrich dietary diversity and nutritional quality [5]. Recent evidence further highlights their suitability for household and controlled-environment production systems, making them a practical option for increasing the availability of fresh, nutrient-rich plant food [6]. However, the nutritional and phytochemical composition of microgreens is highly species-dependant and is influenced by genetic background, environmental conditions, and cultivation practices, resulting in substantial variation among species.

Sunflower Microgreens: Nutritional and Functional Potential

Among the diverse microgreen species available for human consumption, sunflower (*Helianthus annuus* L.) has attracted increasing attention because of its favourable nutritional composition, rapid growth cycle, and potential for functional food applications. Recent investigations have explored strategies to enhance its nutritional quality through optimized nutrient management and agronomic biofortification, resulting in improvements in mineral accumulation, chlorophyll content, antioxidant capacity, and other quality attributes [7][8]. Beyond cultivation, sunflower microgreens have also been investigated as ingredients for value-added foods and for post-harvest quality preservation, reflecting growing scientific interest in maximizing both their nutritional value and practical utilization [9] . Collectively, these studies demonstrate an expanding evidence base for sunflower microgreens; however, research has collectively addressed individual aspects of production, biofortification, post-harvest preservation, or food application rather than providing an integrated biochemical characterization [10].

Research Gap and Study Rationale

However, important knowledge gaps remain regarding the translation of these findings into practical nutritional applications. Existing studies have the primarily examined sunflower microgreens under controlled experimental conditions with emphasis on cultivation optimization, biofortification, post-harvest preservation, or product development, whereas comparatively limited attention has been given to their comprehensive nutritional characterization following simple household cultivation systems [3] [11] [5]. Such evidence is particularly relevant in countries like India, where affordable household production of nutrient-dense foods may contribute to dietary diversification strategies for addressing micronutrient deficiencies. Therefore, the present study evaluated the household cultivation of sunflower microgreens and comprehensively characterized their proximate composition, mineral profile, antioxidant activity, vitamin C, vitamin E, and total flavonoid content to assess their potential as a functional food for improving dietary quality.

2. Materials and Methods

2.1 Plant Material and Household-Scale Cultivation

Untreated sunflower (*Helianthus annuus* L.) microgreen seeds were procured from a commercial supplier (AllThatGrows.in, India). Microgreens were cultivated under simulated household conditions using geo-fabric grow bags (12 x 12 x 16 inches; 500 GSM) filled with hydrated, untreated cocopeat as the growing substrate. Cocopeat was selected because of its favorable water-holding capacity, aeration, and low salinity.

Seeds were rinsed thoroughly under running water and soaked in fresh water for 8-12 h to promote uniform germination. The hydrated substrate was evenly spread in the grow bags, and pre-soaked seeds were uniformly distributed over the surface without nutrient supplementation. Following sowing, the seeds were lightly covered with cocopeat and irrigated by gentle misting to maintain adequate moisture during germination. Thereafter, moisture was maintained by misting once or twice daily as required.

Microgreens were grown under natural indirect sunlight at ambient environmental conditions without artificial lighting or nutrient fortification. Harvesting was performed at the early true-leaf stage (7-10 days after sowing) using sterilized ceramic scissors, approximately 1-2 cm above the substrate surface. Harvested samples were gently rinsed, surface dried, and placed in self-sealing plastic pouches lined with paper towels at 4 ± 1°C until analysis. All the analyses were performed within 48 hours of harvest.

2.2 Nutritional and Phytochemical Analysis

Freshly harvested sunflower microgreens were analyzed for proximate composition, mineral content, antioxidant constituents, and selected antinutritional factors. All analyses were performed in triplicate using standardized analytical procedures.

Moisture, ash, crude protein, crude fat, crude fibre, and carbohydrate contents were determined according to the official methods of AOAC (2019). Carbohydrates content was calculated by difference.

Mineral analysis included iron and zinc estimation using Atomic Absorption Spectrophotometry (Shimadzu AA-7800F), while calcium was determined by the EDTA titrimetric method following AOAC procedures.

Vitamin C was estimated by the 2,6-dichlorophenolindophenol (DCPIP) titrimetric method. Vitamin E and β-carotene were quantified by high-performance liquid chromatography (HPLC). Total phenolic content was determined using the Folin-Ciocalteu assay, total flavonoid content by the rutin colorimetric method, and antioxidant activity using the DPPH radical scavenging assay.

Phytate and oxalate contents were estimated using the spectrophotometric method described by [12].

2.3 Statistical Analysis

All determinations were conducted in triplicate, and results are presented as mean ± standard deviation (SD). As the objective of the study was to characterize the nutritional composition of sunflower microgreens cultivated under household-scale conditions rather than compare experimental treatments, data were summarized using descriptive statistics. Data management and statistical calculations were performed using Microsoft Excel 2016.

3. Results

3.1 Proximate composition

The proximate composition of sunflower microgreens cultivated under household-scale conditions is presented in Table 1. Fresh sunflower microgreens exhibited a high moisture content (80.78 ± 0.03 g/100 g), consistent with their tender vegetative stage. On a fresh weight basis, protein content was 4.08 ± 0.02

g/ 100 g, while carbohydrates, calculated by difference, accounted for 6.26 ± 0.06 g/100 g. Crude fibre content was 2.93 ± 0.04 g/100 g and ash content was 5.94 ± 0.03 g/100 g, indicating the presence of appreciable mineral constituents. Fat content was found to be 4.87 ± 0.20 g/100 g. All analysis were performed in triplicate and the results are presented as mean ± standard deviation.

Table 1. Proximate composition of sunflower microgreens (mean ± SD, n=3)

Parameter	Unit	Value (Mean ± SD)
Moisture	(g/100 g)	80.78 ± 0.03
Ash	(g/100 g)	5.94 ± 0.03
Protein	(g/100 g)	4.08 ± 0.02
Fat	(g/100 g)	4.87 ± 0.20
Crude fibre	(g/100 g)	2.93 ± 0.04
Carbohydrate*	(g/100 g)	6.26 ± 0.06

Values are presented as mean ± SD of triplicate analyses (n = 3).

3.2 Mineral Composition

The mineral composition of sunflower microgreens is presented in table 2. Among the minerals quantified, calcium was the highest (44.67 ± 0.12 mg/100 g), followed by iron (15.63 ± 0.12 mg/100 g), and zinc (0.86 ± 0.01 mg/100 g).

Table 2. Mineral composition of sunflower (Helianthus annuus L.) microgreens

Parameter	Unit	Value (Mean ± SD)
Iron	mg/100 g	15.63 ± 0.12
Zinc	mg/100 g	0.86 ± 0.01
Calcium	mg/100 g	44.67 ± 0.12

Values are presented as mean ± SD of triplicate analyses (n = 3).

3.3 Vitamin, Phytochemical and Antioxidant Profile

The concentrations of antioxidant vitamins, phytochemicals, and antioxidant activity are summarized in Table 3. Sunflower microgreens contained 90.10 ± 0.10 mg/100 g of vitamin C, 0.30 ± 0.05 mg/100 g of vitamin E, and 300 ± 0.10 µg/100 g of β-carotene. The total phenolic and flavonoid contents were 0.03 ± 0.01 mgGAE/100 g and 216.70 ± 0.10 mg RE/100 g, respectively. The DPPH radical scavenging assay demonstrated a DPPH radical scavenging activity of 81.51 ± 0.02 % inhibition.

Table 3. Antioxidant compounds and antioxidant activity of sunflower (Helianthus annuus L.) microgreens

Parameter	Unit	Value (Mean ± SD)
Vitamin C (ascorbic acid)	mg/100 g	90.10 ± 0.10
Vitamin E	mg/100 g	0.30 ± 0.05
Β-Carotene	µg/100 g	300 ± 0.10
Total phenolic content	mg GAE/100 g	0.03 ± 0.01
Total flavonoid content	Mg RE/100 g	216.70 ± 0.10
DPPH radical scavenging activity	% inhibition	81.51 ± 0.02

Values are presented as mean ± SD of triplicate analyses (n = 3).

3.4 Antinutritional Factors

The levels of antinutritional factors quantified in sunflower microgreens are presented in Table 4. Oxalate and phytate contents were 22.32 ± 0.01 mg/100 g and 0.36 ± 0.02 mg/100 g, respectively. The values represent the mean of three independent determinations.

Table 4. Antinutritional factors of sunflower (Helianthus annuus L.) microgreens

Parameter	Unit	Value (Mean ± SD)
Oxalate	mg/100 g	22.32 ± 0.01
Phytate	mg/100 g	0.36 ± 0.02

Values are presented as mean ± SD of triplicate analyses (n = 3).

4. Discussion

The present study provides a comprehensive compositional characterization of sunflower (Helianthus annuus L.) microgreens cultivated under household-scale conditions using a simple, low-input production system. Unlike previous investigations that have primarily focused on cultivation optimization, biofortification strategies, or value-added food applications, the present work was designed to characterize the nutritional profile of sunflower microgreens produced under conditions representative of domestic cultivation. The findings demonstrate that sunflower microgreens harvested at the early true-leaf stage contained appreciable amounts of essential minerals and antioxidant constituents together with relatively low concentrations of antinutritional factors, thereby providing baseline compositional evidence for this comparatively under-characterized microgreen species. While the study was not intended to evaluate health outcomes or cultivation interventions, the generated compositional data contribute to the growing evidence supporting microgreens as nutrient-dense edible plants suitable for inclusion in diversified diets. The proximate composition observed in the present study reflects the physiological characteristics of young developing seedlings. The high moisture content (80.78 g/100 g) is consistent with the rapid cellular expansion and active metabolic processes that characterize the early stages of plant growth and is comparable with values reported for sunflower and several other microgreen species cultivated under controlled and household systems [13][14]. Such high water content contributes to the fresh and highly perishable nature of microgreens while simultaneously diluting energy density, making them nutritionally distinct from mature seeds of the same species [15][16] . Consequently, although sunflower seeds are recognized for their high lipid content, the juvenile tissues analyzed in the present study exhibited a markedly different compositional profile, reflecting the metabolic transition from stored seed reserves to actively growing photosynthetic tissues [17].

Protein content (4.08 g/100 g), carbohydrate content (6.26 g/100 g), and crude fibre (2.93 g/ 100 g) were within the range generally reported for edible microgreens, although absolute values vary considerably among species, harvest stage, cultivation practices, and analytical methodology [14][3]. Such variation is expected because the biochemical composition of microgreens changes rapidly during germination as reserve compounds are mobilized to support seedling establishment and structural development [18]. Rather than representing a stable compositional end-point, nutrient concentrations at this developmental stage reflect dynamic physiological processes influenced by genotype and growing environment. Therefore, direct comparison between studies should be interpreted cautiously, particularly when cultivation conditions, substrates, harvesting stage, or reporting basis differ.

The fat content of sunflower microgreens was 4.87 ± 0.20 g/100 g, reflecting the presence of lipid reserves characteristic of sunflowers and their continued contribution to the biochemical composition of the developing seedling. Although sunflower is an oleaginous crop, lipid reserves accumulated within the seed are progressively mobilized during germination to support respiration, membrane synthesis, and early seedling growth [18]. The low extractable lipid content observed in the harvested microgreens therefore likely reflects both developmental stage and analytical characteristics of fresh vegetative tissues rather than the oil-rich nature of the mature seed itself. Collectively , the proximate composition indicates that sunflower microgreens produced under household-scale cultivation represent a fresh, low-energy plant food characterized by moderate protein and fibre content together with high moisture, providing a nutritional profile that differs substantially from conventional oilseed products.

Conclusion:

The present study characterized the nutritional and selected phytochemical composition of sunflower (*Helianthus annuus* L.) microgreens cultivated under simple household-scale conditions. The microgreens exhibited high moisture content, moderate protein and crude fiber, and measurable concentrations of iron, calcium and zinc. They also contained vitamin C, vitamin E, β-carotene, phenolic and flavonoid compounds, together with measurable DPPH radical-scavenging activity. Oxalate and phytate were detected at the concentrations observed under the conditions of the study. Collectively, these findings provide baseline compositional data for sunflower microgreens produced using a low-input household cultivation approach and support their consideration as a nutrient-dense plant food within dietary diversification. However, the study was limited to descriptive biochemical characterization under a single cultivation system and did not assess bioavailability, dietary intake, health outcomes, or comparative effects of cultivation conditions. Further studies incorporating standardized cultivation conditions, bioavailability assessment, broader phytochemical characterization, and evaluation of dietary applications are warranted to establish the nutritional significance of sunflower microgreens more comprehensively.

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References:

1. Burchi, F., Fanzo, J., & Frison, E. (2011). The role of food and nutrition system approaches in tackling hidden hunger. *International Journal of Environmental Research and Public Health*, *8*(2), 358–373. https://doi.org/10.3390/ijerph8020358
2. Bamji, M. S., Murty, P. V. V. S., & Sudhir, P. D. (2020). Nutritionally sensitive agriculture—an approach to reducing hidden hunger. *European Journal of Clinical Nutrition*, *75*(7), 1001–1009. https://doi.org/10.1038/s41430-020-00760-x
3. Teng, J., Liao, P., & Wang, M. (2021). The role of emerging micro-scale vegetables in human diet and health benefits—an updated review based on microgreens. *Food & Function*, *12*(5), 1914–1932. https://doi.org/10.1039/d0fo03299a
4. Kainikkara, F. S., Shams, R., Dash, K. K., & Béla, K. (2025). Development strategies and processing effects on the nutritional and bioactive composition of microgreens: A comprehensive review. *Applied Food Research*, *5*(2), 101280. https://doi.org/10.1016/j.afres.2025.101280
5. Seth, T., Mishra, G. P., Chattopadhyay, A., Roy, P. D., Devi, M., Sahu, A., Sarangi, S. K., Mhatre, C. S., Lyngdoh, Y. A., Chandra, V., Dikshit, H. K., & Nair, R. M. (2025). Microgreens: functional food for nutrition and dietary diversification. *Plants*, *14*(4), 526. https://doi.org/10.3390/plants14040526
6. Zhang, Y., Xiao, Z., Ager, E., Kong, L., & Tan, L. (2021). Nutritional quality and health benefits of microgreens, a crop of modern agriculture. *Journal of Future Foods*, *1*(1), 58–66. https://doi.org/10.1016/j.jfutfo.2021.07.001
7. Sirinupong, M., Bourchookarn, A., Htwe, N. M. P. S., Sae-Ong, M., & Ruangrak, E. (2024). Enhancing sunflower microgreen yield and quality through foliar application of various nutrient solutions. *Agriculture and Natural Resources*, *58*(4), 487-500. https://doi.org/10.34044/j.anres.2024.58.4.09
8. Poudel, P., Di Gioia, F., Lambert, J. D., & Connolly, E. L. (2023). Zinc biofortification through seed nutri-priming using alternative zinc sources and concentration levels in pea and sunflower microgreens. *Frontiers in Plant Science*, *14*, 1177844. https://doi.org/10.3389/fpls.2023.1177844
9. Mansouri, M., Noshad, M., Mehrnia, M. A., & Hojjati, M. (2024). Sunflower microgreen powder as functional component to enhance the quality of gluten-free cakes. *LWT*, *198*, 116049. https://doi.org/10.1016/j.lwt.2024.116049
10. Rani, S., Singh, N., Kaur, C., & Varghese, E. (2024). Measurement of phytochemical content and nutritional characteristics of microgreens grown in high altitude region of India. *Journal of Food Measurement & Characterization*, *18*(5), 3113–3127. https://doi.org/10.1007/s11694-024-02390-4
11. Dubey, S., Harbourne, N., Harty, M., Hurley, D., & Elliott-Kingston, C. (2024). Microgreens Production: Exploiting Environmental and Cultural Factors for Enhanced Agronomical Benefits. *Plants*, *13*(18), 2631. https://doi.org/10.3390/plants13182631
12. Singh, G., Kawatra, A., & Sehgal, S. (2001). Nutritional composition of selected green leafy vegetables, herbs and carrots. Plant Foods for Human Nutrition, 56(4), 359–364. https://doi.org/10.1023/a:1011873119620
13. Polash, M. a. S., Sakil, A., Sazia, S., & Hossain, A. (2019). Selection of suitable growing media and

nutritional assessment of microgreens. Agricultural Research Journal, 56(4), 752. https://doi.org/10.5958/2395-146x.2019.00116.9

14. Ghoora, M. D., Haldipur, A. C., & Srividya, N. (2020). Comparative evaluation of phytochemical content, antioxidant capacities and overall antioxidant potential of select culinary microgreens. Journal of Agriculture and Food Research, 2, 100046. https://doi.org/10.1016/j.jafr.2020.100046
15. Azarpazhooh, E., Sharayei, P., Sabeghi, Y., & Gandomzadeh, D. (2026). Influence of packaging systems and storage conditions on quality attributes, antioxidant capacity, and microbial stability of garden cress (Lepidium sativum L.) microgreens. *Food Chemistry Advances*, *10*, 101250. https://doi.org/10.1016/j.focha.2026.101250
16. Turner, E. R., Luo, Y., & Buchanan, R. L. (2020). Microgreen nutrition, food safety, and shelf life: A review. Journal of Food Science, 85(4), 870–882. https://doi.org/10.1111/1750-3841.15049
17. CHELBEA, E.-M., DOBRESCU, A., BADEA, M., BĂLAN, D., LUȚĂ, G., GHERGHINA, E., & University of Agronomic Sciences and Veterinary Medicine of Bucharest. (2019). THE INFLUENCE OF THE RESERVE LIPIDS CONTENT ON SEED GERMINATION AT SUNFLOWER HYBRIDS. In Scientific Papers. Series a. Agronomy. https://agronomyjournal.usamv.ro/pdf/2019/issue_1/Art34.pdf
18. Erbaş, S., Tonguç, M., & Şanli, A. (2016). Mobilization of seed reserves during germination and early seedling growth of two sunflower cultivars. Federal Research Centre for Cultivated Plants (Julius Kühn-Institut). https://doi.org/10.5073/jabfq.2016.089.028
19. AOAC. (2019). Official Methods of Analysis of the Association of Official Analytical Chemists: Official Methods of Analysis of AOAC International. 21st Edition, AOAC, Washington DC.