



Microgreens: Acceptance and Perception of Consumers

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Abstract: Microgreens, young greens derived from various plant seeds are packed with essential nutrients and bioactive compounds. Farmers invest in them due to high market demand and rapid production cycle. With their abundance of phytochemicals, microgreens demonstrate strong antioxidant properties and have the potential to prevent chronic diseases. All around the globe there is a proactive search for health-promoting foods and microgreens can be the answer. The current study assessed the consumer perception and acceptance of microgreens. An online survey was administered and was answered by 150 people aged 20-35 years to assess consumer awareness about microgreens. A ranking scale and 5-point Likert scale were employed to rank the constraints in purchasing microgreens and to assess consumers' perception, respectively. In addition, a sensory analysis of five microgreen varieties i.e., radish (white, purple, and pink), beetroot, and carrot was carried out in the campus of Banasthali Vidyapith by an untrained panel of 100 people using a 9-point hedonic scale. The results of online survey revealed that only 100 respondents out of 150 were familiar with microgreens hence answered further question which were regarding their understanding of microgreens. A positive inclination towards microgreens was seen, especially regarding their benefits on personal and gut health. Few constraints such as lack of awareness, high perishability, and pricing concerns were also highlighted by the general population. Additionally, the results of sensory evaluation revealed that the 64.6% consumers expressed a liking for microgreens. Beetroot and carrot microgreens varieties were most accepted by consumers.

Key words: Microgreens, consumer acceptance, awareness, perception, sensory analysis

Microgreens, a specialty crop, are gaining a lot of attention for indoor gardening, upscale grocery stores, and fine dining establishments, due to their appealing appearance, texture, and flavor (Yeargin *et al.*, 2023). They are recognized for their diverse range of colors, textures, and flavors, making them a favorite in culinary settings as both garnishes and toppings as they potentially elevate the sensory qualities of meals (Michell *et al.*, 2020). Microgreens constitute young and tender premature greens derived from the seeds of diverse

plant species, encompassing vegetables, herbs, wild edibles, and grains. A diverse array of seeds, such as arugula, celery, red beet, green basil, and buckwheat from the *Brassicaceae*, *Apiaceae*, *Amaranthaceae*, *Chenopodiaceae*, *Lamiaceae*, and *Poaceae* families, have been utilized to cultivate microgreens. However, there are some unsuitable varieties for microgreen cultivation including plants like tomatoes, peppers, eggplants, and those with anti-nutrients during the seedling stages (Du *et al.*, 2022). These nascent greens are typically harvested a few days or weeks (10-20 days) after the cotyledons reach full growth and the initial true leaves emergence (Yeargin *et al.*, 2023). Numerous urban and peri-urban farms have invested in cultivating them due to their high market value, quick production cycle, and also consumer attraction towards them (Kyriacou *et al.*, 2016).

At present, the large-scale cultivation of microgreens is commonly carried out in greenhouses as the greenhouse method efficiently mitigates the influence of environmental pollution on microgreens, and also ensures their availability year-round (Du *et al.*, 2022), resulting in a safer nutrient-rich agriculture produce throughout the year. Prolonged consumption of fruits and vegetables can pose a threat to consumers as modern agricultural practices involve heavy doses of fertilizers. On the other hand, microgreen farming does not involve such chemicals hence become a safer food choice (Bhaswant *et al.*, 2023). In a few cases microgreen phase of a plant is safer to consume as compared to seed. For instance, peanuts, as germinated peanuts undergo transformative protein changes that reduce allergenic proteins, rendering peanut microgreens suitable for individuals with peanut allergies (Du *et al.*, 2022). Several studies confirm that microgreens are capable of improving consumers' dietary patterns more effectively than mature vegetables as they contain more concentrated nutrients as compared to their counterparts (Renna *et al.*, 2020; Kyriacou *et al.*, 2021; Sharma *et al.*, 2022). Microgreens serve as valuable reservoirs of nutrients and antioxidants, encompassing vitamin C, carotenoids, phenolic compounds, and minerals like copper and zinc (Zhang *et al.*, 2021). Acharya *et al.* (2021) studied beet microgreens throughout their growth cycle

and reported that betalains stood out as the predominant pigment followed by chlorophyll. They also confirmed that all the pigments were at their peak on the 15th day of their growth cycle. The ascorbic acid content varied from 35 to 51 mg 100 g⁻¹ on a fresh matter basis (FM). It can be said that microgreens are economically viable and nutritionally packed agricultural produce. Consumers are actively seeking a novel food product that promotes health and longevity and delivers a flavorful culinary adventure (Chen *et al.*, 2020). As consumers play a pivotal role in shaping new trends within the food industry (Yeargin *et al.*, 2023), their satisfaction with the new food product is immensely important and also the main focal point for the food industry. Consumers' preferences and needs determine whether a novel food is accepted or rejected. Food acceptability is shaped by consumer attitudes like knowledge, innovation, attitude, belief, and perception of specific food products. The feel-good factor, ultimately, stands out as a crucial determinant in determining the acceptability of food (Maina, 2018).

While numerous studies have investigated the production and cultivation of microgreen varieties, there is a scarcity of research on consumer perception and acceptance of microgreens globally. However, this study bridges this gap by examining the acceptance of microgreens among the general population in India. Furthermore, it also explores the knowledge and perception of microgreens among Indian consumers, providing valuable insights into their preferences and potential adoption.

Materials and Methods

The research investigation was carried out in two distinct phases. Initially, an evaluation of consumer perception was conducted utilizing a self-designed questionnaire. The questionnaire was tailored to analyze the perspectives, attitudes, and opinions of consumers regarding microgreens.

Subsequently, the second phase of the study delved into assessing consumer acceptance and preference for various microgreen species. The aim was to understand consumer choices and discern any notable trend in their preference for specific microgreen varieties. The two phases of the study have contributed to a comprehensive

understanding of both consumer perceptions and preferences. Further elaboration on each of the phases is presented below.

Consumer perception: An online survey was administered in August 2023 to assess consumer perspective and awareness regarding microgreens using a self-designed questionnaire. People aged 20-35 years were asked to fill the survey, as this age group represents a significant portion of the target market for various products. Also, their openness to new trends and dietary choices makes their perception and preferences reflect the current market trend. Potential respondents were sent a self-designed questionnaire through non-random sampling on social media platforms requesting their participation. A total of 150 consumers answered the questions. Before floating on social-media the questionnaire was tested for its reliability using Cronbach's alpha test. Other than general details the survey encompassed questions about familiarity with microgreens, their definition, duration since initial exposure, source of information, purchasing locations, and cost of microgreens. The opening question in the google form was if the respondents are familiar with microgreens. Out of 150 respondents, 100 opted for any one option from "recognize but never tasted, tasted but do not use, occasional use, frequent use" as the response, indicating their familiarity with microgreens. So, further questions were responded by 100 people. This part sought their perception about the concept they have of microgreens, their source of information about microgreens, the purchasing sources, and the cost. The next part dwelled upon the constraints for not purchasing the microgreens. and for this ranking test was used. Respondents marked seven different factors on a rank scale of 1 to 7 with 1 being the strongest constraint and 7 the weakest. The 5-point Likert scale from strongly disagree as 1 and strongly agree as 5 was used to get insight about the general perception lay persons have about microgreens.

Consumer acceptance: Five varieties of microgreens viz., radish (white, purple, and pink), beetroot, and carrot were purchased from Living Greens Organic, Jaipur, Rajasthan at Rs. 150 per 100 g. The microgreens were harvested on the same day and were stored in plastic clamshell containers at 4 to 5°C for further

use. All the purchased samples went through a thorough cleaning process like washing under running water, and proper removal of excess water and residue. The stored samples were acclimated to room temperature for 10 minutes before serving. To assess the acceptability of the micro-scale vegetable, a consumer panel from the campus of Banasthali Vidyapith, Rajasthan, India was selected. A convenience sample of consumers (n=100) aged between 20 to 35 years, without aversions to green leafy vegetables, non-smokers and not being treated for cold, flu, allergies, or nausea, participated in the study. Consumer acceptance was assessed using a 9-point hedonic scale ranging from 9 (liked extremely) to 1 (disliked extremely) (Michell *et al.*, 2020). Five grams of each microgreen species was served to the panelist on a white plate and labeled alphabetically for blinding purposes. The evaluation spanned six sessions over three days with a maximum of 17 participants per session. Participants were instructed to cleanse their palates using water in between the tasting sessions and were seated separately in a quiet environment to reduce discussion. A detailed instruction on the testing procedure and test samples were given to the participants before the sessions commenced.

Statistical Analysis: Collected data was stored electronically and was analyzed using IBM SPSS 20.0 Version Statistics Software. The reliability of the self-designed questionnaire for evaluating consumer perception and awareness about microgreens was assessed using Cronbach's alpha test. Descriptive statistical analysis was performed. The results are reported as mean and standard deviation (Mean $\pm$ S.D.) wherever needed.

Results and Discussion

A reliability test was conducted to evaluate the consistency of respondent's answers and a value of 0.69 was achieved for Chronbach's alpha. It is suggested that Cronbach's alpha value between 0.6 and 0.8 is considered acceptable (Nawi *et al.*, 2020).

Consumer Perception: The mean age (years) of the study group was 25.92 ± 3.21 years and 54% were between 25 to 29 years of age. Among the 150 participants included in the study, 40 (26.7%) identified as males and 110 (73.3%) as females. More than half of the participants i.e., 81 (54%) individuals of the total sample

size fell within the range of 25 to 29 years. Additionally, there were 48 respondents (32%) of the participants, in the age group 20 to 24 years, and 21 participants (14%), in the age group 30 to 35 years. The study encompassed a diverse participant profile, revealing a varied educational background and occupational spectrum. Notably, a significant portion of 48% held post-graduate qualifications. Moreover, 35.33% were graduates and 13.33% of the participants possessed doctorate degrees, signifying a substantial inclination towards higher education. A total of 43% respondents were enrolled as students, while 38.66% were engaged in service-related professions, indicating a significant workforce contribution to various service sectors. Furthermore, 7.33% owned businesses, indicating an entrepreneurial segment within the sample, and 4.7% were identified as housewives. The predominant religious practice among the participants was Hinduism followed by Jainism. The majority (27.3%) of participants reported a monthly income ranging from Rs. 92,951 to 85,894. A quarter of respondents (26%) reported a monthly income of $\geq 1,85,895$ Rupees. Notably, a large segment of the population was single (84%), with only 14.7% reporting being married. A significant proportion (40.7%) of participants adhered to a vegetarian diet along with dairy products (Lacto-vegetarian) while 28% of the participants followed a non-vegetarian diet, indicating a sizable segment that included meat or animal products in their food choices. Moreover, 17.30% of the participants followed a lacto-ovo-vegetarian diet, which allows both dairy and eggs in addition to plant-based foods. Lastly, 14% of the participants adhered to a vegan diet, a notable portion who abstained from all animal-derived products.

In response to the question regarding their familiarity with microgreens 50 (33.3%) participants reported not recognizing the microgreens and hence were excluded from further assessment (Table 1). However, the remaining participants showcased varying degrees of awareness and interaction with microgreens.

A substantial portion of participants accounting for 41.3% of participants, acknowledged being aware of microgreens but had not tasted them yet. Additionally, 10.7% of the participants reported having tasted

microgreens but were not actively using them. A smaller fraction, comprising 10% of respondents, indicated occasional use of microgreens while, a minor fraction of participants, totaling 4.7% reported frequent consumption of microgreens. A majority (71%) of the total respondents, correctly identified microgreens as young plants. However, a notable portion, comprising 18% of the population, confused microgreens with sprouts. Additionally, 9% of the participants recognized microgreens as fully-grown vegetables. A small percentage, i.e., 2% of the respondents, identified microgreens as genetically modified plants, reflecting a misconception or misinterpretation regarding the classification and nature of microgreens among the study group.

Approximately 36% of participants were first introduced to microgreens within the past 1 to 2 years, signifying a significant portion who had recently encountered microgreens within this time frame. However, 20% of the respondents indicated that their introduction to microgreens occurred between 3 to 4 years ago, while 17% reported being aware about these from the past 5 years. A significant fraction, constituting 27% of the participants, had their first encounter with microgreens less than a year before the study was conducted. The primary influencers (36%) in spreading information about microgreens were friends and relatives, suggesting a significant impact through personal networks in sharing knowledge about microgreens. Additionally, 32% attributed their knowledge acquisition to television and social media platforms, indicating the substantial role the media played in raising awareness about microgreens. Furthermore, 20% acknowledged health professionals or chefs as influential sources of information, highlighting the impact of expert opinions in shaping perceptions about microgreens. Lastly, 12% of the participants reported obtaining information about microgreens from newspapers or magazines. Most consumers (22%) relied on homegrown microgreens, indicating a preference for self-cultivation or home production of the greens. Additionally, 15% and 13% of consumers favored organic product shops and supermarkets as their primary purchasing spot for microgreens, respectively. However, a smaller portion, only 8%, relied on online sites for purchasing microgreens. Furthermore, 5% of consumers

Table 1. Distribution of participants with respect to the awareness towards microgreens

Statements	Responses	Frequency (N=150)
Familiarity with microgreens	Do not recognize	50
	Recognize but never tasted	62
	Tasted but do not use	16
	Occasional use	15
	Frequent use	7
Statements	Responses	Frequency (N=100)
Microgreens are	Young tender plant smaller than baby greens	71
	Sprouts grown in water	18
	Fully grown vegetables	9
	Genetically modified plants	2
Initial introduction about microgreens	5 years	17
	3-4 years	20
	1-2 years	36
	Less than a year	27
Source of information about microgreens	Friends/Relatives	36
	Newspaper/Magazine	12
	T.V./Social-Media	32
	Health Professionals/Chef	20
For purchasing microgreens you rely on	Supermarket	13
	Organic product shop	15
	Producers' farms	5
	Online sites	8
	Homegrown	22
	Do not purchase	37
100 g microgreens on average costs	Rs. 100-200	18
	Rs. 201-300	25
	Rs. 301-400	7
	More than Rs. 400	2
	No idea about the cost	48

reported obtaining microgreens directly from producers' farms. Nearly half, specifically 48% of the respondents, indicated being unaware of the price of microgreens, suggesting a lack of knowledge regarding their cost. However,

among those who provided estimations, 25% perceived the price of 100 g of microgreens to fall within the range of 201-300 rupees. Additionally, 18% estimated the cost to be between 100-200 rupees for the same quantity

Table 2. Weighted average for ranking the constraints in purchasing the microgreens

Constraints	Rank							Weighted Mean	Final Rank
	I	II	III	IV	V	VI	VII		
	Frequency (n)								
Lack of general awareness	41	8	7	4	7	6	27	3.54	II
Lack of easy availability	7	24	13	9	7	15	25	4.30	IV
High price	2	5	48	11	16	11	7	3.95	III
Dislike for microgreens	4	1	10	55	11	7	12	4.37	V
Lack of knowledge about health benefits	3	2	16	10	51	11	7	4.65	VI
Fearing of trying new foods	3	13	4	5	6	49	20	5.25	VII
High perishability	40	47	2	6	2	1	2	1.94	I

Table 3. Distribution of the participants for the consumers' perception pattern towards microgreens using Likert scale

Statements	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
	Frequency (n)				
Microgreens have beneficial impact on personal health	67	11	2	6	14
Consuming microgreens is trendy	50	12	20	8	10
Microgreens promote gut health	55	18	13	4	10
Microgreens are safe for consumption	57	23	7	1	12
Individuals with ailments such as diabetes, thyroid, high/low blood pressure can consume microgreens	58	18	11	2	11
Microgreens repair damage caused by unhealthy diet	54	21	12	2	11
If consumed in excess, then harmful results can be seen	30	11	42	8	9
Microgreens are expensive	47	15	21	7	10
Microgreens are value for money	43	25	15	6	11
Microgreens have to be eaten raw, not processed	44	16	20	8	12
Microgreens juices are readily available in market	35	6	31	15	13
There is a need for less perishable value-added products made using microgreens	55	19	13	4	9

of microgreens while 9% of the participants believed that the cost exceeded 301 rupees for 100g of microgreens.

Seven constraints for purchasing microgreens were ranked by the respondents, 1 being the highest and 7 being the lowest, and the weighted mean and ranks are presented in table 2. The primary reason cited by respondents for not purchasing microgreens was their high perishability. Following closely, the second ranked factor was the lack of general awareness about microgreens, as noted by respondents. The issue of high pricing occupied the third rank. Respondents recognize lack of easy availability of microgreens as the fourth-ranked constraint. Additionally, respondents expressed dislike for microgreens as the fifth obstacle. Respondents opted lack of knowledge about health benefits of microgreens as the sixth-ranked constraint, while the fear of trying new foods was noted as the seventh-ranking constraint in the list by the respondents.

The data (Table 3) suggests a strong positive perception of microgreens across various aspects of health and consumption. A vast majority expresses strong agreement that microgreens positively impact personal health (67%), promote gut health (55%), are safe for consumption even for healthy individuals (57%) as well as for individuals with health ailments (58%), and aid in repairing damage from an unhealthy diet (54%). Around 50%

believe that consuming microgreens is a trending food choice. However, while there is a favorable view toward microgreens, some reservations exist. For instance, there's a concern expressed by 30%, regarding potential harmful effects when consumed in excess. There's also a mixed perception about the cost, with a significant portion, around 47%, strongly agreeing that microgreens are expensive, yet nearly 43% consider them to be value for money. The 44% participants agreed that microgreens should be consumed raw and not in processed forms whereas neutral and disagreement was also evident among the participants. Similarly, there's ambiguity about the availability of microgreens juices in the market, as 31% were not sure about the presence and absence of microgreens-based-beverage. One notable aspect is that there's a need for less perishable value-added products using microgreens as this was agreed by 74% participants, indicating a potential market demand for such offerings. This points towards an opportunity for developing and introducing longer-lasting products made with microgreens. Overall, the survey indicates a prevailing positive sentiment toward the health benefits of microgreens, though with nuanced opinions about their consumption, cost, and availability in various forms but also signifies the approval and interest in incorporating microgreens into daily diet.

Table 4. Mean hedonic scores for consumer acceptability of microgreens varieties

Microgreen Variety	Mean Score
White Radish Microgreens	6.04 ± 1.75
Beetroot Microgreens	6.20 ± 1.74
Purple Radish Microgreens	5.81 ± 2.05
Pink Radish Microgreens	5.74 ± 2.13
Carrot Microgreens	6.27 ± 2.27

Consumer acceptability: The mean score of consumer acceptability test using the 9-point hedonic scale is shown in table 4. Findings indicated that 64.6% of panelists expressed a liking for microgreens. Specifically, 10.8% reported an extreme liking, 13.4% liked them very much, 20% liked them moderately, and 20.4% liked them slightly. On the other hand, 21.6% of panelists did not like microgreens, while 13.8% neither liked nor disliked them.

Breaking it down by microgreens varieties, beetroot microgreens received the highest liking, with 70% of panelists expressing a liking, and only 15% expressing a dislike. Carrot microgreens followed closely, with a 67% liking and a 21% dislike rate. White radish microgreens were liked by 66% of respondents and disliked by 17%, purple radish microgreens garnered a 61% liking and a 25% disliking response. Pink radish microgreens were liked by 59% of panelists, while 30% did not express a liking for them.

Few previous studies explored microgreens perception and acceptance and found that 69% of the study population had not consumed microgreens whereas 82% had never purchased them (Chen *et al.*, 2020). Whereas in a study done by Yeargin *et al.* (2023) it was noted that a significant portion of participants bought microgreens from stores, and only 33.5% cultivate them and Michell *et al.* (2020) found that all six microgreen varieties included in the study scored in between 6.0 to 7.9 indicating acceptance among the consumers. Also, a confusion between microgreens and sprouts were noted in the previous studies as well which might be due to the novelty of microgreens in the market. In addition, it is crucial to emphasize that microgreens are microbiologically safer than sprouts and also contain pigments which are lacking in sprouts. As during harvesting, microgreens are obtained without roots and seed coats, minimizing the

risk of contamination from both the growing media and the seeds. This sets them apart from sprouts, where these two sources often contribute to contamination issues during sprout preparation (Verlinden, 2020).

Conclusion

In conclusion, this study explores the multifaceted aspects of microgreens, emphasizing their increasing popularity in various settings. Microgreens have become a favored choice in culinary settings as they can be derived from diverse plant species and offer a wide range of colors, textures, and flavors. The cultivation of microgreens is noted for its quick production cycle and high market value. Consumer perception and acceptance of microgreens are explored through an online survey and sensory evaluation. Despite some constraints such as lack of awareness, high perishability, and pricing concerns, there is a positive inclination towards microgreens, especially regarding their health benefits. The research also sheds light on consumer preferences and identifies potential market demand for less perishable value-added products using microgreens. The sensory evaluation reveals that beetroot and carrot microgreens received higher liking. This comprehensive study not only contributes to the existing knowledge on the sensory acceptance of microgreens but also explores consumer perceptions and awareness, offering valuable insights for both researchers and the food industry. Future research could delve deeper into specific aspects of microgreen nutritional content, cultivation, and production to further enhance understanding of this emerging and promising agricultural produce.

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