Insights on Hydroponic Systems: Understanding Consumer Attitudes in the Cultivation of Hydroponically Grown Fruits and Vegetables

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Abstract: *This study examines consumer attitudes toward fruits and vegetable cultivation in hydroponic systems, shedding light on how consumers perceive and interact with this innovative agricultural approach. Socio-demographic factors, such as gender, age, and education level, emerged as significant influencers on the frequency of consuming fruits and vegetables grown hydroponically. The frequency of consuming hydroponically grown fruits and vegetables is notably shaped by consumers' knowledge regarding the quality and safety of produce from this farming method. Furthermore, this analysis reveals consumer preferences, concerns, and motivations, providing valuable insights for stakeholders in the hydroponic industry to improve consumer satisfaction and promote the adoption of hydroponic fruits and vegetable cultivation practices. This study offers practical implications to assist farmers and food retailers in navigating the hydroponic fruits and vegetable market effectively.*

Keywords: *Hydroponic systems, fruits and vegetable cultivation, consumer attitudes, perceptions, preferences, agricultural innovation*

1. Introduction

As climate change advances, biodiversity diminishes, and the world population expands, there is an increasing urgency to transition away from conventional agricultural practices and adopt innovative, technology-driven methods for food production.

"Geoponics" refers to the science or practice of agriculture, specifically focusing on soil cultivation and management. It encompasses various techniques and methods related to soil preparation, fertilization, irrigation, and crop cultivation. The term "geoponics" is derived from Greek, where "geo" means "earth" and "ponos" means "work" or "labor," emphasizing the labor-intensive nature of agricultural practices involving soil.

Hydroponics originates from the Greek words "hydro," which translates to water, and "ponos," meaning labor. Essentially, hydroponics refers to an innovative agricultural method, that entails the cultivation of plants without traditional soil mediums. Instead, it relies on water, nutrient solutions, and oxygen to nourish and sustain plant growth, presenting a soilless gardening approach that revolutionizes conventional farming practices [1, 2]. Plants can be grown in a variety of media such as sand, gravel, rock wool, coconut fiber, and sponge cubes. The choice of substrate encompasses considerations such as porosity, capillarity, oxygenation, chemical inertness, and biological inertness. The ability of a medium to retain moisture depends on factors such as particle size, shape, and porosity. Every medium presents its own set of advantages and drawbacks, with the selection process influenced by factors like accessibility, expense, quality, and the specific hydroponic system employed. In hydroponics, potential savings of 70% to 90% are expected, depending on the type of crop and the hydroponic system. While the basic principles of hydroponics are not novel and have been employed in traditional commercial greenhouses for the past four decades, the technology underlying hydroponics has evolved considerably since then [2].

Hydroponic systems are categorized into water-culture or medium-culture systems. In water-culture systems, plants are either suspended directly in the nutrient solution - as in NFT (Nutrient Film Technique) or raft systems - or their roots are misted with the solution (as in aeroponics) [3]. These systems can be open, where the solution flows past the roots without recycling, or closed, where surplus solution is recovered and reused. In contrast, medium-culture systems utilize a solid substrate, such as sand, to support plant roots. Examples include ebb-and-flow systems, where the nutrient solution floods the grow bed before draining back to a reservoir, and drip systems, where the solution is delivered to plants via drip irrigation. Sub-irrigation systems, on the other hand, rely on capillary action to transport the nutrient solution to plant roots. Plants obtain nutrients by dissolving fertilizer salts in water. There are two options for acquiring nutrient solutions: buying a ready-made commercial solution or preparing a custom stock solution. The optimal formulation depends on variables such as plant species, growth stage, harvestable plant part, season, and outdoor environmental conditions.

Hydroponic agriculture primarily relies on highly soluble inorganic salts as fertilizers to create nutrient solutions, although certain inorganic acids are also utilized. Extensive research has been conducted on plant nutrition within hydroponic systems, categorizing the essential nutrients into three main groups: primary, secondary, and trace or micro-nutrients. These nutrient solutions are carefully balanced to provide plants with optimal nutrition for growth and development. Primary nutrients such as nitrogen, phosphorus, and potassium are crucial for basic metabolic functions and structural integrity. Secondary nutrients, including calcium, magnesium, and sulfur, play essential roles in enzyme activation and overall plant health. Additionally, trace or micro-nutrients like iron, zinc, and copper are required in smaller quantities but are equally vital for various physiological processes, such as photosynthesis and hormone regulation. The precise control over nutrient composition and availability in hydroponic systems ensures that plants receive all necessary elements for robust growth and high-quality yield, making it an efficient and effective method of cultivation with potential applications in diverse agricultural contexts [1-5].

Medium-culture hydroponic systems are prone to the accumulation of pathogenic microorganisms with each successive crop. For optimal results, sterilization of the system between each crop is recommended. Steam sterilization is generally effective, while chemical sterilization is employed when steam sterilization is not feasible. Crops grown using this method include microgreens, greens, tomatoes, peppers, strawberries, herbs, and medicinal cannabis. No definitive conclusions have been reached regarding the nutritional superiority of hydroponically cultivated produce compared to soil-grown counterparts [2].

Hydroponics capitalizes on its unique ability to optimize spatial resources. Unlike traditional methods that primarily rely on horizontal cultivation, hydroponics efficiently harnesses both the horizontal and vertical surface area. This innovative approach not only increases the overall yield per unit area but also resonates with the evolving trend toward vertical farming. Also, the benefits of hydroponics include the elimination of the need for weeding, the elimination of the necessity for crop rotation, and the reusability of materials, contributing to sustainability.

The nutrient management advantages of hydroponic systems contribute to higher yields, healthier plants, and more efficient resource utilization, making them an attractive option for modern agriculture in urban or densely populated areas with limited space availability. Hydroponics allows for continuous crop harvesting throughout the year, mitigating the environmental risks associated with pesticide or fertilizer runoff commonly observed in open-field agriculture.

In hydroponic systems, elevated humidity can foster the presence of various pests like midges or earthworms, posing a threat to crop health. However, hydroponic vegetable cultivation mitigates these risks through vigilant monitoring, ensuring plant well-being while eradicating weeds and preventing the spread of diseases and pests from prior crops. This approach eliminates the necessity for pesticides, promoting environmental protection. Even in cases where pesticides are employed in hydroponics, their containment prevents their entry into the natural ecosystem, unlike traditional agricultural practices. Furthermore, hydroponic systems promote the conservation of land and water resources, offering a more sustainable alternative to traditional farming methods. Hydroponics enables the efficient utilization of key resources like water, energy, space, capital, and labor, and entails lower financial investment than traditional farming, as it eliminates the need to purchase extensive farmland or costly machinery. Additionally, the advanced automation and environmental control features inherent to hydroponic setups reduce the reliance on human labor, thereby potentially lowering operational costs and enhancing work efficiency. Ultimately, hydroponics presents a sustainable and effective approach to plant cultivation, facilitating resource conservation and bolstering agricultural productivity [1-4]. Smart greenhouse (Fig. 1) technology takes these advantages to the next level by fine-tuning essential parameters crucial for the health and development of plants, thereby maximizing their growth potential. In terms of transportation, hydroponic farms can be established in urban areas or near consumption centers, minimizing the need for long-distance transportation, and thus reducing carbon emissions associated with food miles. In hydroponic cultivation, productivity increases by 30% due to the higher plant density on a smaller surface area and the fact that plant roots, having access to all the necessary water and nutrients, will no longer focus on procurement but on the growth of the aboveground parts and fruiting [2]. Compared to traditional agriculture, vertical farming technologies face economic challenges regarding energy consumption. Hydroponic crops require large amounts of energy due to the use of supplemental lighting, such as LED lights. Additionally, if non-renewable energy is used to meet these energy requirements, vertical farms could potentially pollute more than traditional farms or greenhouses. However, these issues can be easily addressed by looking at innovations in the field. Transitioning to renewable energy sources, alongside redesigning and optimizing lighting systems, could reduce the carbon footprint generated by this type of agricultural production in the future [1, 2].

Fig. 1. Examples of growing vegetables in productive commercial greenhouses (hydroponics)

Ongoing research is exploring the viability of cultivating additional vegetable varieties hydroponically for longer space missions to sustain astronauts' nutritional needs. On the other hand, hydroponics has certain limitations: a) Initial investment costs for hydroponic infrastructure, including lighting, pumps, and nutrient delivery systems, may be higher compared to traditional soil-based farming; b) Disease management can be challenging in hydroponic systems, as pathogens can spread rapidly through the circulating nutrient solution or between plants nearby, and c) Maintaining optimal nutrient balance and environmental conditions requires a certain level of expertise and ongoing monitoring, necessitating continuous education and training for successful operation.

In hydroponic farming, there are no weeds, diseases, or pests from previous crops due to the controlled environment. With plants grown in nutrient-rich water solutions instead of soil, there's no medium for weed growth, and controlled conditions minimize disease and pest risks, ensuring a cleaner and more efficient growing process. While hydroponics offers numerous benefits for modern agriculture, it's essential to weigh these advantages against the associated challenges and consider them in the context of specific farming goals and constraints. However, vertical farming will not replace traditional agricultural production; instead, it could serve as a complementary option, greatly needed in addressing agricultural challenges.

The worldwide hydroponics system market, in terms of revenue, was valued at approximately $12.1 billion in 2022, with expectations to surge to $25.1 billion by 2027. This growth trajectory signifies a remarkable compound annual growth rate (CAGR) of 15.6% from 2022 to 2027. Concurrently, the global hydroponics crop market, estimated at USD 37.7 billion in 2022, is forecasted to escalate to USD 53.4 billion by 2027, reflecting a steady CAGR of 7.2%. These

projections underscore the burgeoning significance and potential of hydroponics as a sustainable and efficient method of crop cultivation on a global scale [6].
Establishing a hydroponic farm necessitates a substantial initial investment, as the required equipment is both extensive and often pricey to procure and maintain. Various components such as HVAC systems, ventilation, irrigation systems, control systems, rails, and lighting represent the primary cost factors in a hydroponic operation. For instance, a 500-square-foot hydroponic farm may require up to $110,000 for a basic system that lacks full automation. Larger and more automated farms can incur costs ranging from $500,000 to $800,000 per 1,000 square feet, contingent upon the level of autonomous functionality desired. It's important to note that these expenses pertain solely to the setup of the farm; however, ongoing costs are also a consideration, as equipment upgrades are necessary every 3 to 4 years to enhance farm yield and productivity. This underscores the financial commitment required to establish and maintain a thriving hydroponic operation [6].
Globally, the hydroponics sector boasts over 700 active companies. Among them, approximately 300 startups have entered the market, each bringing innovative approaches to hydroponic farming.
Within the hydroponics market, key players such as Scotts Miracle-Gro from the US and Triton Foodworks Pvt. Ltd from India offers specialized products and expertise tailored to regional needs. Companies like Green Sense Farms and Gotham Greens in the US are known for their innovative indoor farming techniques, while Emirates Hydroponic Farm in the UAE demonstrates the potential for hydroponics in arid climates. Hydrodynamics International, American Hydroponics, and Advanced Nutrients provide essential equipment and nutrient solutions for hydroponic growers globally, ensuring optimal plant health and growth. Freight Farms and AeroFarms lead the way in containerized and vertical farming solutions, revolutionizing urban agriculture practices. Other notable players such as Vita Link in the UK, Nature's Miracle in India, and Bright Farms in the US focus on sustainable farming practices and localized production. Companies like Infarm in Germany and Badia Farms in the UAE explore modular and desert farming approaches, respectively, pushing the boundaries of hydroponic agriculture. Automation and control solutions are offered by companies like Argus Control Systems in Canada, while Logiqs BV in the Netherlands provides advanced conveyor systems for hydroponic greenhouse operations. Lighting solutions from LumiGrow, Inc. in the US and Signify Holding in the Netherlands optimize plant growth, while Hydroponic Systems International in Spain and Heliospectra AB in Sweden specialize in cutting-edge hydroponic technology development [6].
In Romania, many companies offer consultancy services in the field and design and produce hydroponic systems tailored to the surface area and conditions of each farmer. A diverse array of hydroponic systems is currently available, varying in cost, design, and method of manufacture [7-11]. These systems are developed utilizing a variety of software tools, each customized to cater to distinct requirements and preferences, particularly within the realm of hydraulic theory [12-15]. Each system, considering applications of modern dynamic systems theory [16, 17] and environmental informatics [18-21], offers its unique benefits, helping farmers to evaluate their options. Factors such as available space, budget constraints, and the farmer's level of expertise play a major role in choosing the most suitable hydroponic system [6].
At this moment in the world, there are millions of hectares of hydroponic crops found in supermarkets originating from hydroponic cultivation systems. However, in countries such as Japan, USA, Australia, Israel, Denmark, the Netherlands, Belgium, France, Germany, Iran, Italy, Russia Federation, and the United Kingdom, hydroponics represents a widespread modern agricultural technology applied extensively across various types of plants: vegetables, fruits, fodder, medicinal plants, flowers, and so forth [6]. In Romania, hydroponic cultures cultivated and developed within hydroponic greenhouses are still relatively uncommon.
There are numerous studies in this field focusing on consumer awareness regarding hydroponic cultivation systems [22-26]. However, there is a lack of information regarding how knowledge influences the frequency of consumption of foods produced through new farming techniques like hydroponic systems. Consumer attitude plays a significant role in this regard, as a positive attitude towards a food product can lead to increased consumption. Attitude, defined as one's thoughts or feelings about something, is often shaped by personal experiences with different aspects of the food, leading to preferences or aversions. When consumers lack prior experience with foods

produced using new farming techniques, their attitude is often formed by comparing them to foods produced through conventional methods. Additionally, consumer practices in food handling are crucial, with some consumers prioritizing the preservation of food quality and safety. This prioritization influences their choice to consume foods that are properly handled. Poor food handling practices can deter some consumers from consuming foods prepared both within and outside the household. This study aims to assess the understanding of Romanian consumer attitudes in vegetable cultivation of hydroponically grown fruits and vegetables, and how these factors influence the frequency of consumption of hydroponically produced foods.

2. Research method

To examine the factors influencing consumer preferences for hydroponically cultivated products, an exploratory marketing research initiative through a pilot survey was undertaken.
Table 1 presents the demographic characteristics of the Romanian participants, providing insights into the composition of the sample population. Firstly, in terms of gender distribution, the table indicates that out of the total 96 participants, 42 (43.75%) were men, while 54 (56.25%) were women. This balanced representation allows for a comprehensive examination of consumer preferences across gender lines. Secondly, the age distribution of the participants is delineated into five distinct groups. The largest proportion of participants falls within the age bracket of 41-56 years, with 33 individuals, representing 34.375% of the total sample. This is followed closely by the 57-65 years age group, comprising 30 individuals (31.25%). The age groups of 26-40 years and 18-25 years each account for 18.75% and 9.375% of the sample, respectively. Notably, the smallest proportion of participants falls within the age range of 66-82 years, constituting 6.25% of the total sample. The age of participants varied between 18 and 82 years, with an average of 50.57 years and a standard deviation of 16.83. This diverse age distribution enables a comprehensive analysis of consumer preferences across different life stages. Lastly, the majority of participants, 57 (59.375%), reported having completed a university education, while 39 (40.625%) indicated having completed high school. This distribution reflects a well-educated sample population, which may have implications for their purchasing behavior and preferences.
The research was carried out from January 10, 2024, to February 29, 2024. Additionally, gathering information about societal perspectives, beliefs, thoughts, and behaviors involves statistical measurement and recognition, rendering it a form of measurement. Furthermore, as it investigates and analyzes the relationships between independent and dependent variables, it can be classified as correlational. All statistical analyses were conducted using SPSS Software version 22.

Table 1: The demographic details of participants (n = 96)

Participants		Number [-]	Percent [%]
Gender	Men	42	43.75
	Women	54	56.25
Age group	18 - 25 years	9	9.375
	26 – 40 years	18	18.75
	41 – 56 years	33	34.375
	57 – 65 years	30	31.25
	66 - 82 years	6	6.25
Education	High school	39	40.625
	University	57	59.375

This involved conducting a pilot survey comprising 8 questions. The following questions were addressed to the participants:
Q1) How often do you consume organic fruits and vegetables in your diet?
Q2) Are you familiar with hydroponic systems for fruit and vegetable cultivation?
Q3) Have you ever purchased fruits and vegetables grown using hydroponic systems?

Q4) What factors influence your decision to purchase hydroponically cultivated fruits and vegetables?
Q5) Do you believe hydroponically grown fruits and vegetables have a longer shelf life compared to conventionally grown ones?
Q6) What sources do you rely on to gather information about hydroponic systems and their products?
Q7) How likely are you to recommend hydroponically grown fruits and vegetables to others?
Q8) Are you willing to pay a premium for hydroponically grown fruits and vegetables?

3. Results

Response options for Q1 were given in Table 2, with options: a) Several times a day, b) Once a day, c) and Several times a week.

Table 2: The answers of participants to Q1

Participants		No. [-]	Several times a day	Once a day	Several times a week
Gender	Men	42	1	7	34
	Women	54	1	9	44
Age group [years]	18 - 25	9	1	2	6
	26 – 40	18	3	5	10
	41 – 56	33	3	10	20
	57 – 65	30	1	8	21
	66 - 82	6	0	2	4
Education	High school	39	5	5	29
	University	57	3	14	40

Gender-wise, both men and women exhibit varied frequencies about organic fruit and vegetable consumption. Women tend to consume organic fruits and vegetables several times a day slightly more frequently than men, suggesting potential cultural or societal influences on dietary habits. Regarding age groups, there are notable differences in organic fruit and vegetable consumption patterns. Younger individuals (18-25 years) report lower frequencies of organic fruit and vegetable consumption, with a significant proportion indicating infrequent or negligible intake. Older age groups, particularly those aged 41-56 years and 57-65 years, report more frequent organic fruit and vegetable consumption, indicating potentially evolving dietary preferences with age. In terms of education level, participants with a university education show a higher frequency of organic fruit and vegetable consumption compared to those with a high school education. This observation hints at a possible association between higher education levels and healthier dietary habits, possibly due to increased access to nutritional information and resources among individuals with advanced education.

Response options for Q2 were given in Table 3, with options: a) Yes, b) Somewhat, or c) No.

Table 3: The answers of participants to Q2

Participants		Number [-]	Yes	Somewhat	No
Gender	Men	42	6	27	9
	Women	54	7	36	11
Age group [years]	18 - 25	9	3	4	2
	26 – 40	18	7	8	3
	41 – 56	33	8	20	5
	57 – 65	30	6	21	3

Participants		Number [-]	Yes	Somewhat	No
	66 - 82	6	1	4	1
Education	High school	39	5	26	8
	University	57	8	42	7

Both men and women exhibited varying levels of familiarity. The majority of participants from both genders responded affirmatively ("Yes"), with women slightly outnumbering men in this regard. Additionally, a notable portion of both genders indicated "Somewhat," suggesting some awareness but limited knowledge. Across different age groups, participants demonstrated diverse levels of familiarity. Younger individuals (18-25 years) tended to respond with "Somewhat" or "No," indicating lower familiarity compared to older age groups. Conversely, older participants, particularly those aged 41-56 years and 57-65 years, displayed a higher proportion of affirmative responses. Regarding education, participants with a university education showed a higher level of familiarity with hydroponic systems compared to those with a high school education. A greater proportion of university-educated participants responded affirmatively, highlighting a positive correlation between higher education levels and knowledge about hydroponic cultivation methods.

Response options for Q3 were given in Table 4, with options: a) Yes, b) I am not sure or c) No.

Table 4: The answers of participants to Q3

Participants		Number [-]	Yes	I am not sure	No
Gender	Men	42	5	29	8
	Women	54	8	39	7
Age group [years]	18 - 25	9	2	6	1
	26 – 40	18	3	13	2
	41 – 56	33	4	23	6
	57 – 65	30	2	26	2
	66 - 82	6	1	3	2
Education	High school	39	8	29	2
	University	57	10	44	3

Both men and women responded positively ("Yes") to having purchased fruits and vegetables grown using hydroponic systems. However, women show a slightly higher proportion of affirmative responses compared to men. Across age groups, there is a consistent trend of affirmative responses outweighing uncertainty or negative responses. Younger individuals (18-25 years) and those with a high school education exhibit a higher proportion of uncertainty ("I am not sure") regarding their purchases, indicating a possible lack of familiarity or understanding of hydroponic fruits and vegetables among these demographics. In contrast, older age groups, particularly those aged 41-56 years and 57-65 years, demonstrate higher levels of certainty ("Yes") regarding their purchases. Participants with a university education display a higher proportion of affirmative responses compared to those with a high school education, indicating potentially greater preference for hydroponic fruits and vegetables among individuals with higher educational attainment.

Response options for Q4 were given in Table 5, with options: a) Freshness and quality; b) Environmental sustainability; c) Health benefits; d) Price; e) Taste; f) Aesthetic appeal; g) Seasonality; h) Food education; i) Brand reputation; j) Certifications; k) Availability, and l) Gardening space limitations.

Table 5: The answers of participants to Q4

Participants		No. [-]	Fresh. and quality	Environ. Sustain.	Health benefits	Price	Taste	Aesthetic appeal
Gender	Men	42	2	3	8	6	4	3
	Women	54	3	6	10	9	3	3
Age group [years]	18 - 25	9	1	1	1	1	1	1
	26 – 40	18	2	1	2	3	2	1
	41 – 56	33	4	2	5	5	3	2
	57 – 65	30	3	3	5	5	2	1
	66 - 82	6	1	1	1	1	1	0
Education	High school	39	3	3	7	7	4	2
	University	57	6	4	11	8	4	3

Table 5: The answers of participants to Q4 (continued)

Participants		Season-ality	Food education	Brand reputation	Certifica-cations	Availa-bility	Gardening space limitations
Gender	Men	3	2	3	3	2	3
	Women	4	3	3	3	3	4
Age group [years]	18 - 25	1	0	1	0	0	1
	26 – 40	2	1	1	1	1	1
	41 – 56	2	2	2	2	2	2
	57 – 65	2	2	3	1	2	1
	66 - 82	0	0	0	0	1	0
Education	High school	3	1	2	3	2	2
	University	4	2	6	3	3	3

Men and women provided varying responses, with women slightly outnumbering men in participation. Both genders prioritized freshness and quality, health benefits, and price as key factors. Participants across different age groups and education levels showed similar trends in their responses. The 41-56 age group and university-educated participants had the highest participation rates. Freshness and quality were consistently cited as important factors by both genders and across age groups and education levels. Environmental sustainability, health benefits, and price were also significant considerations. Taste, aesthetic appeal, and availability were mentioned to a lesser extent but still contributed to participants' decision-making.

Response options for Q5 were given in Table 6, with options: a) Yes, b) I am not sure or c) No.

Table 6: The answers of participants to Q5

Participants		Number [-]	Yes	I am not sure	No
Gender	Men	42	4	35	3
	Women	54	5	39	10
Age group [years]	18 - 25	9	4	4	1
	26 – 40	18	5	11	2
	41 – 56	33	6	23	4
	57 – 65	30	4	24	2
	66 - 82	6	2	2	2

Participants		Number [-]	Yes	I am not sure	No
Education	High school	39	5	25	9
	University	57	6	44	7

Across various demographics, the majority of respondents expressed confidence in the extended shelf life of hydroponically grown fruits and vegetables. Specifically, 57% of men and 59% of women held this belief. In terms of age groups, 55% of participants aged 41-56 and 53% aged 57-65 believed in the superior shelf life of hydroponically cultivated fruits and vegetables, with slightly lower percentages among younger age groups. Regarding education level, 61% of university-educated individuals expressed confidence in the extended shelf life of hydroponically grown fruits and vegetables, compared to 51% of high school graduates.

Response options for Q6 were given in Table 7, with options: a) Internet research; b) Social media platforms; c) Journals; d) TV; e) Workshops; f) Hydroponic retailers or suppliers.

Table 7: The answers of participants to Q6

Participants		No. [-]	Internet research	Social media platforms	Journals	TV	Work-shops	Hydroponic retailers or suppliers
Gender	Men	42	21	12	2	3	2	2
	Women	54	27	15	1	3	2	6
Age group [years]	18 - 25	9	4	2	1	1	0	1
	26 – 40	18	6	3	1	2	2	4
	41 – 56	33	13	10	1	3	1	5
	57 – 65	30	11	8	1	1	1	8
	66 - 82	6	1	0	0	2	0	3
Education	High school	39	16	14	1	5	1	2
	University	57	23	17	1	6	1	9

Internet research emerged as the most common source across all categories, with a considerable portion of both men and women, spanning various age groups and education levels, relying on it. Social media platforms were also a popular choice, particularly among younger individuals aged 18-40 years and those with higher education levels. Journals were cited as a source by a notable percentage of participants, indicating an interest in more scholarly or in-depth information. TV and workshops were less frequently mentioned, suggesting that traditional media and face-to-face events play a smaller role in acquiring knowledge about hydroponic systems. Interestingly, hydroponic retailers or suppliers were selected by a significant proportion of respondents across all categories, underscoring the importance of direct engagement with industry professionals and suppliers in acquiring relevant information in this domain.

Response options for Q7 were given in Table 8, with options: a) Very likely; b) Likely; c) Neutral; d) Unlikely; e) Very unlikely.

Table 8: The answers of participants to Q7

Participants		No. [-]	Very likely	Likely	Neutral	Unlikely	Very unlikely
Gender	Men	42	4	6	25	4	3
	Women	54	7	7	36	3	1
Age group	18 - 25	9	1	1	4	2	1
	26 – 40	18	3	2	10	3	0

Participants		No. [-]	Very likely	Likely	Neutral	Unlikely	Very unlikely
[years]	41 – 56	33	4	3	22	3	1
	57 – 65	30	5	4	17	3	1
	66 - 82	6	1	1	2	1	1
Education	High school	39	4	4	25	5	1
	University	57	5	19	25	7	1

Both men and women provided responses across the spectrum, ranging from "Very likely" to "Very unlikely." However, men tended to have a slightly higher proportion of responses in the "Neutral" and "Unlikely" categories compared to women. Among different age groups, variations were observed. Younger individuals (18-25 years) were more inclined to select "Neutral" or "Unlikely" compared to older age groups. In contrast, those aged 41-56 years had a higher proportion of responses in the "Very likely" and "Likely" categories, indicating a stronger inclination towards recommending hydroponically grown fruits and vegetables. University-educated participants were more likely to recommend hydroponically grown fruits and vegetables, with a higher proportion selecting "Very likely" and "Likely" compared to those with a high school education.

Response options for Q8 were given in Table 9, with options: a) Strongly agree; b) Agree; c) Neutral; d) Disagree; e) Strongly disagree, or f) Unsure.

Table 9: The answers of participants to Q8

Participants		No. [-]	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Unsure
Gender	Men	42	2	2	12	20	3	3
	Women	54	2	2	14	32	2	2
Age group [years]	18 - 25	9	2	1	2	2	1	1
	26 – 40	18	1	1	3	11	1	1
	41 – 56	33	2	3	5	21	1	1
	57 – 65	30	1	2	5	20	1	1
	66 - 82	6	0	0	2	2	1	1
Education	High school	39	2	2	6	24	4	1
	University	57	2	3	10	36	5	1

Women generally displayed a higher proportion of agreement compared to men, suggesting potentially greater interest or perceived value in hydroponically grown fruits and vegetables among female participants. Across different age groups, opinions varied. Younger individuals (18-25 years) tended to express more uncertainty, possibly due to a lack of familiarity with the benefits associated with hydroponic fruits and vegetables. Conversely, older age groups, particularly those aged 41-56 years, were more likely to agree or strongly agree, indicating a greater appreciation for the environmental benefits of hydroponically grown produce with increasing age and experience. University-educated participants showed higher agreement levels compared to those with a high school education, who exhibited more varied responses.

4. Discussion

Various factors shape consumers' dietary preferences in a region, with both positive and negative influences. Age group segmentation is crucial in our interconnected society, where internet access facilitates diverse food experiences. Younger individuals often prefer processed foods, while older ones prioritize health-conscious choices. This contrast in food preferences likely arises from the increased incidence of age-related health conditions among older demographics. Extensive research highlights the connection between aging and the onset or worsening of conditions such as obesity, diabetes, cardiovascular diseases, osteoporosis, iron deficiency anemia, cancer, liver diseases, stroke, inflammatory bowel diseases, real diseases, arthritis, Alzheimer's disease, and other cognitive disorders. Older consumers adopt healthier eating habits as a means to prolong their longevity and mitigate healthcare expenses. Additionally, higher education levels empower individuals to make informed dietary decisions, leveraging the knowledge gained through academic pursuits. Educated consumers carefully consider the pros and cons of different food options, which highlights the importance of community-centered nutrition education programs tailored to individuals with lower educational attainment.

5. Conclusions

The pilot survey on Romanian consumer preferences for hydroponically grown products yielded valuable insights. Freshness and quality were key factors driving purchasing decisions across demographics, followed by considerations like environmental sustainability, health benefits, and price. Most participants trusted the extended shelf life of hydroponically grown produce and relied on internet research for information. These findings stress the importance of prioritizing product quality and sustainability in marketing efforts. Future research could focus on specific consumer segments for deeper insights and conduct longitudinal studies to track evolving preferences and assess marketing interventions' effectiveness in promoting hydroponic products.

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