

PERCEIVED VALUE AND PURCHASE INTENTION OF HYDROPONIC VEGETABLES: TRUST, SUSTAINABILITY, AND QUALITY ATTRIBUTES IN CONSUMER ACCEPTANCE

VALOR PERCEBIDO E INTENÇÃO DE COMPRA DE HORTALIÇAS HIDROPÔNICAS: CONFIANÇA, SUSTENTABILIDADE E ATRIBUTOS DE QUALIDADE NA ACEITAÇÃO PELO CONSUMIDOR

VALOR PERCIBIDO E INTENCIÓN DE COMPRA DE LAS HORTALIZAS HIDROPÓNICAS: CONFIANZA, SOSTENIBILIDAD Y ATRIBUTOS DE CALIDAD EN LA ACEPTACIÓN DE LOS CONSUMIDORES

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ABSTRACT

Hydroponics and soilless cultivation systems have gained visibility as alternatives for vegetable production under controlled conditions, with potential benefits related to resource-use efficiency, regular supply, and food safety. However, consumer acceptance of these products depends on how attributes such as quality, safety, sustainability, naturalness, trust, price, and concrete benefits are perceived. This integrative review aimed to analyze the factors associated with perceived value and purchase intention for hydroponic vegetables and foods produced in soilless systems, vertical farming, and indoor agriculture. A systematized search was conducted in May 2026 in the OpenAlex bibliographic index. Studies published between 2019 and 2026 in Portuguese, English, or Spanish were considered. After title, abstract, and thematic screening, 18 studies composed the main corpus. The findings were organized into six thematic categories: quality attributes and perceived value; trust, information, traceability, and food safety; perceived sustainability and environmental communication; naturalness, artificiality, and technology acceptance; price, willingness to pay, and purchase intention; and consumer segments, familiarity, and adoption readiness. The synthesis indicated that perceived value is shaped by the interaction between quality attributes, informational trust, perceived sustainability, technological familiarity, and price evaluation. Sustainability alone does not ensure purchase intention; it must be translated into verifiable attributes, such as freshness, safety, traceability, lower resource use, and health-related benefits. The findings suggest that the market advantage of hydroponic vegetables depends less on the production technology itself and more on the communication of understandable, reliable, and economically meaningful benefits to consumers.

Keywords: Hydroponics. Consumer Behavior. Perceived Value. Purchase Intention. Sustainability.

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RESUMO

A hidroponia e os sistemas de cultivo sem solo ganharam visibilidade como alternativas para a produção de hortaliças em condições controladas, apresentando benefícios potenciais relacionados à eficiência no uso de recursos, ao abastecimento regular e à segurança alimentar. No entanto, a aceitação desses produtos pelos consumidores depende da percepção de atributos como qualidade, segurança, sustentabilidade, naturalidade, confiança, preço e benefícios concretos. Esta revisão integrativa teve como objetivo analisar os fatores associados ao valor percebido e à intenção de compra de hortaliças hidropônicas e alimentos produzidos em sistemas sem solo, agricultura vertical e agricultura em ambiente fechado. Uma busca sistematizada foi realizada em maio de 2026 na base bibliográfica OpenAlex. Foram considerados estudos publicados entre 2019 e 2026 nos idiomas português, inglês ou espanhol. Após a triagem de títulos, resumos e temas, 18 estudos compuseram o corpus principal. Os resultados foram organizados em seis categorias temáticas: atributos de qualidade e valor percebido; confiança, informação, rastreabilidade e segurança alimentar; sustentabilidade percebida e comunicação ambiental; naturalidade, artificialidade e aceitação de tecnologia; preço, disposição a pagar e intenção de compra; e segmentos de consumidores, familiaridade e prontidão para adoção. A síntese indicou que o valor percebido é moldado pela interação entre atributos de qualidade, confiança na informação, sustentabilidade percebida, familiaridade tecnológica e avaliação de preço. A sustentabilidade, por si só, não garante a intenção de compra; ela precisa ser traduzida em atributos verificáveis, como frescor, segurança, rastreabilidade, menor uso de recursos e benefícios relacionados à saúde. Os resultados sugerem que a vantagem competitiva das hortaliças hidropônicas depende menos da tecnologia de produção em si e mais da comunicação de benefícios compreensíveis, confiáveis e economicamente relevantes para os consumidores.

Palavras-chave: Hidroponia. Comportamento do Consumidor. Valor Percebido. Intenção de Compra. Sustentabilidade.

RESUMEN

Los sistemas de cultivo hidropónico y sin suelo han ganado protagonismo como alternativas para la producción de hortalizas en condiciones controladas, con beneficios potenciales relacionados con la eficiencia en el uso de los recursos, el suministro regular y la seguridad alimentaria. Sin embargo, la aceptación de estos productos por parte de los consumidores depende de cómo se perciban atributos como la calidad, la seguridad, la sostenibilidad, la naturalidad, la confianza, el precio y los beneficios concretos. Esta revisión integradora tuvo como objetivo analizar los factores asociados al valor percibido y a la intención de compra de hortalizas hidropónicas y alimentos producidos en sistemas sin suelo, agricultura vertical y agricultura de interior. En mayo de 2026 se llevó a cabo una búsqueda sistematizada en el índice bibliográfico OpenAlex. Se tuvieron en cuenta los estudios publicados entre 2019 y 2026 en portugués, inglés o español. Tras una selección por título, resumen y temática, el corpus principal quedó compuesto por 18 estudios. Los resultados se organizaron en seis categorías temáticas: atributos de calidad y valor percibido; confianza, información, trazabilidad y seguridad alimentaria; sostenibilidad percibida y comunicación medioambiental; naturalidad, artificialidad y aceptación de la tecnología; precio, disposición a pagar e intención de compra; y segmentos de consumidores, familiaridad y disposición a la adopción. La síntesis indicó que el valor percibido viene determinado por la interacción entre los atributos de calidad, la confianza en la información, la sostenibilidad percibida, la familiaridad con la tecnología y la evaluación del precio. La sostenibilidad por sí

sola no garantiza la intención de compra; debe traducirse en atributos verificables, como la frescura, la seguridad, la trazabilidad, un menor uso de recursos y beneficios relacionados con la salud. Los resultados sugieren que la ventaja comercial de las hortalizas hidropónicas depende menos de la propia tecnología de producción y más de la comunicación de beneficios comprensibles, fiables y económicamente significativos para los consumidores.

Palabras clave: Hidroponía. Comportamiento del Consumidor. Valor Percibido. Intención de Compra. Sostenibilidad.



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INTRODUCTION

The production and consumption of vegetables have been reshaped by concerns related to food safety, urbanization, efficient water use, and the growing appreciation of foods perceived as healthy, safe, and environmentally responsible. In this context, hydroponics and soilless cultivation systems have gained relevance because they allow greater control of the nutrient solution, intensive use of space, production near consumer markets, and reduction of some uncertainties associated with climate and soil.

However, the acceptance of hydroponic vegetables does not automatically result from their technical characteristics. For consumers, production technology must be converted into perceived value. This value involves functional, symbolic, and economic benefits, such as freshness, appearance, taste, safety, absence or reduction of residues, traceability, sustainability, availability, convenience, and a price considered fair. At the same time, highly technological systems may activate perceptions of artificiality, distrust, or distance from the idea of natural food.

Recent literature shows that hydroponics is evaluated in dialogue with other production systems, such as organic production, conventional agriculture, urban farming, vertical farming, plant factories, and indoor agriculture. Studies on hydroponic tomatoes, lettuce, parsley, leafy greens, and vertically farmed produce suggest that quality and sustainability attributes can favor purchase intention, but they also reveal that lack of knowledge, technological neophobia, price, and lack of informational trust operate as relevant barriers (D'amico *et al.*, 2024; Califano; Crichton-Fock; Spence, 2024; Torres *et al.*, 2025; Zhou; Asioli; Jürkenbeck, 2025).

Therefore, the guiding question of this review is: which attributes influence the perceived

value and purchase intention of hydroponic vegetables and foods from soilless or controlled-environment systems? The study is justified by the fragmentation of the literature across sustainability, trust, quality, naturalness, willingness to pay, and acceptance of agricultural technologies. Integrating these findings makes it possible to understand not only whether consumers accept hydroponic products, but why, under what conditions, and with what implications for communication, marketing, and market development.

The general objective of this article is to analyze, through an integrative review with a systematized search, the factors associated with perceived value and purchase intention of hydroponic vegetables, emphasizing trust, sustainability, and quality attributes. Specifically, the article seeks to identify attributes valued by consumers; discuss the role of trust, information, and traceability; analyze how perceived sustainability affects acceptance; recognize barriers to purchase intention; and propose an integrative synthesis model.

METHODOLOGY

This study is characterized as an integrative review with a systematized search. An integrative review is appropriate when the objective is to bring together empirical studies, reviews, and conceptual discussions on a multidimensional phenomenon, allowing narrative synthesis and thematic organization of findings (Whittemore; Knafl, 2005; Souza; Silva; Carvalho, 2010).

The bibliographic search was conducted on May 9, 2026, in the OpenAlex bibliographic index, with DOI and metadata verification on publisher platforms when available. The strategy combined four blocks of terms in English: system/product, consumer, value attributes, and behavioral outcome. Terms included hydroponic vegetables, hydroponics, soilless farming, vertical farming, controlled environment agriculture, indoor farming, consumer acceptance, purchase intention, consumer perception, perceived value, willingness to pay, trust, sustainability, food quality, food safety, naturalness, and traceability.

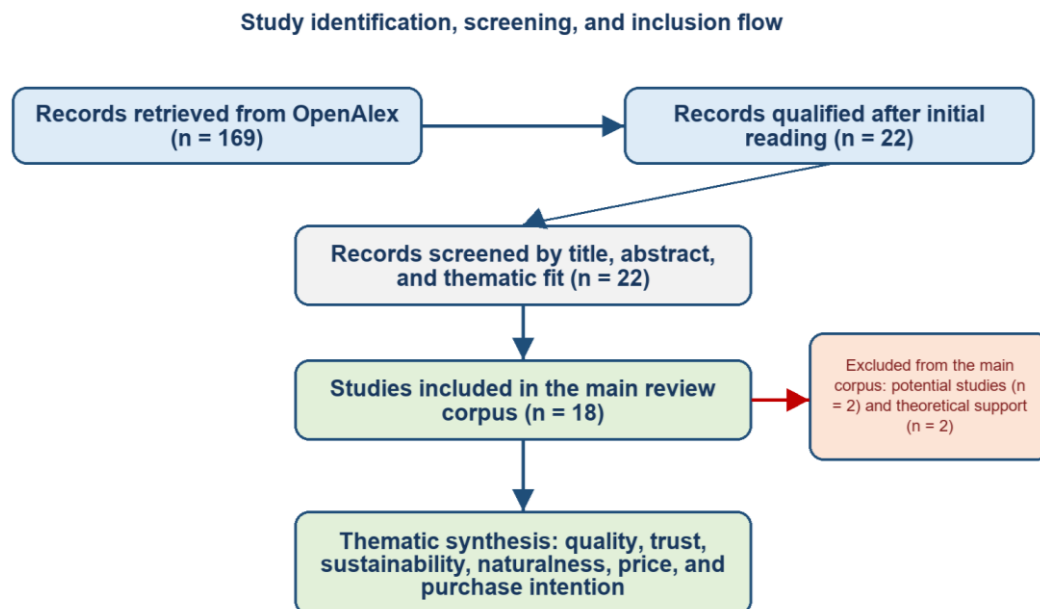
Peer-reviewed articles, reviews, and scientific works retrievable with verifiable metadata were included when published between 2019 and 2026 in Portuguese, English, or Spanish and when they addressed perception, acceptance, purchase intention, willingness to pay, trust, sustainability, or perceived value regarding hydroponic vegetables, foods from soilless systems, vertical farming, indoor agriculture, or controlled environment agriculture. Exclusively

agronomic studies, texts without consumer variables, duplicates, and studies on agricultural technologies without a direct relationship with perception, acceptance, or consumer markets were excluded.

The search considered up to 169 records ranked by relevance across the different term combinations. After title and abstract screening, 22 studies were qualified for eligibility assessment. Of these, 18 composed the main review corpus, two were kept as potential studies for thematic expansion, and two were used only as theoretical support on trust and green products. Data extraction included authorship, year, journal or event, system/product analyzed, method, perceived value dimension, trust factors, sustainability attributes, barriers, and implications for purchase intention.

The synthesis was narrative and thematic, organized into six analytical categories: quality attributes and perceived value; trust, information, traceability, and food safety; perceived sustainability and environmental communication; naturalness, artificiality, and technology acceptance; price, willingness to pay, and purchase intention; and consumer segments, familiarity, and adoption readiness.

Figure 1. Study identification, screening, and inclusion flow



Source: prepared by the authors (2026), based on OpenAlex search and DOI metadata verification.

RESULTS AND DISCUSSION

Characterization of the Corpus

The main corpus included 18 studies published between 2019 and 2025, with a predominance of recent research, especially from 2023 to 2025. The analyzed literature covered hydroponics, foods from soilless systems, vertical farming, indoor agriculture, and controlled environment agriculture. Although not all studies deal exclusively with hydroponic vegetables in a strict sense, all contribute to understanding how consumers evaluate products obtained from technologically mediated production systems.

From a methodological perspective, the corpus combined empirical consumer studies, literature reviews, and conceptual syntheses. This heterogeneity is compatible with the integrative approach and makes it possible to observe both direct evidence of purchase intention and broader explanatory mechanisms, such as trust, familiarity, perceived naturalness, sustainability framing, and comparison with organic or conventional products.

Table 1. Synthesis of the studies included in the main corpus

Authors/year	System product or	Study focus	Contribution to the review
D'Amico <i>et al.</i> (2024)	Hydroponic tomato	Willingness to pay	Sustainability and quality increase perceived value when linked to verifiable benefits.
Zhou, Asioli and Jürkenbeck (2025)	Soilless systems	Perception review	Integrates findings on acceptance, naturalness, familiarity, communication, and purchase intention.
Califano, Crichton-Fock and Spence (2024)	Parsley/hydroponics	Preferences for production systems	Shows that hydroponics is evaluated in comparison with urban farming and robotic cultivation.
Torres <i>et al.</i> (2025)	Lettuce	Explicit and implicit perception	Highlights tensions between technology, naturalness, and preference for more familiar systems.
Jürkenbeck, Heumann and Spiller (2019)	Vertical farming	Consumer acceptance	Perceived sustainability appears as a relevant antecedent of acceptance.
Gan, Soukoutou and Conroy (2023)	Controlled environment agriculture	Sustainability framing review	The way sustainability is communicated changes consumer interpretation.
Yano <i>et al.</i> (2023)	Indoor farming/LED	Information effect	Information about the system reduces uncertainty and improves safety

			perception.
Yano <i>et al.</i> (2021)	Vertically farmed produce	Consumer attitudes	Identifies associations between perceived attributes, familiarity, and evaluation of vertically farmed products.
Jaeger (2024)	Plant factory/vertical farming	Consumer insights synthesis	Discusses barriers and facilitators related to naturalness, quality, and acceptance.
Ezni Balqiah <i>et al.</i> (2020)	Hydroponics	Economic and ecological attractiveness	Relates hydroponic attractiveness to perceived ecological and economic benefits.
Pedroso <i>et al.</i> (2023)	Hydroponic vegetables	Traceability and information	Shows the relevance of origin, sanitation, packaging, and information for Brazilian consumers.
Melz, Riefle and Bitsch (2021)	Vertical farming	Young consumer perception	Analyzes market readiness, familiarity, and openness among young consumers.
Reis, Friedman and Bitsch (2023)	Indoor agriculture	Benefits versus advanced technology	Shows that sustainability benefits can coexist with concerns about technology.
Siegrist <i>et al.</i> (2023)	Sustainable food technologies	Multi-country acceptance	Shows that risk, trust, and familiarity influence acceptance of sustainable technologies.
Schnack <i>et al.</i> (2024)	Sustainable agricultural technologies	Adoption readiness	Distinguishes consumer groups according to openness to future agricultural technologies.
Pfeiffer, Gabriel and Gandorfer (2021)	Digital farming technologies	Public attitudinal acceptance	Helps explain trust, risk, and social legitimacy in agricultural technologies.
Grebitus <i>et al.</i> (2023)	Vertical farming and organic produce	Expectations and experiences	Compares sensory and symbolic expectations in relation to organic products.
Hartmann <i>et al.</i> (2023)	Vertically farmed produce	Purchase likelihood	Compares consumers with higher and lower stated likelihood of buying vertically farmed produce.

Source: prepared by the authors based on the review corpus.

Quality Attributes and Perceived Value

The studies indicate that perceived quality is the most concrete entry point for value formation. Freshness, appearance, taste, safety, regularity, and hygiene are easily understandable attributes, whereas environmental or technological benefits require greater translation. In the study by D'Amico *et al.* (2024), willingness to pay for hydroponic tomatoes was influenced by sustainability and quality attributes, suggesting that consumers evaluate hydroponics not only as a production technique but as a promise of benefit in the final product.

The review by Zhou, Asioli and Jürkenbeck (2025) reinforces that foods from soilless systems can be perceived positively when associated with safety, traceability, local production, and lower exposure to environmental risks. However, acceptance is not homogeneous. Consumers may recognize productive advantages and simultaneously question taste, naturalness, or food authenticity.

Comparison with organic products appears as a sensitive dimension. Grebitus *et al.* (2023) show that expectations and experiences with vertically farmed products can be evaluated in relation to the imaginary of naturalness and quality associated with organic products. This means that hydroponics must build its own identity: it is not enough to occupy the same symbolic space as organic food, because its differentials lie in control, safety, standardization, and efficiency.

Trust, Information, Traceability, and Food Safety

Trust acts as a mediator between technical attributes and purchase intention. In technologically mediated and green markets, consumers tend to depend on signals, certifications, producer reputation, origin information, and point-of-sale communication. Hansen *et al.* (2020) and Nuttavuthisit and Thøgersen (2017) show, in related fields, that trust is a condition for converting sustainability claims into decision security.

In the case of hydroponic vegetables, traceability can transform an invisible technology into a verifiable benefit. Pedroso *et al.* (2023), in a Brazilian study, emphasize the importance of information about origin, sanitation, packaging, and hydroponic production for consumer perception. This suggests that communication should move beyond generic sustainability claims and present verifiable elements, such as origin, water and nutrient control, absence or reduction of residues, and hygiene standards.

The study by Yano *et al.* (2023) is particularly relevant because it shows that information about the functioning of indoor production with LED can improve consumer reaction. This finding indicates that initial resistance to technology is not necessarily fixed; it can be reduced when consumers understand the process and its benefits. Communication should therefore be pedagogical without becoming excessively technical.

Perceived Sustainability and Environmental Communication

Perceived sustainability is one of the most recurrent dimensions in the corpus, but the studies converge on one point: by itself, it is not enough to ensure purchase intention. Jürkenbeck, Heumann and Spiller (2019) indicate that sustainability matters in the acceptance of vertical farming systems; however, Gan, Soukoutou and Conroy (2023) show that sustainability framing in controlled environment agriculture must be carefully constructed to avoid ambiguity, exaggeration, or perceptions of greenwashing.

Consumers may value water savings, lower soil use, local production, and reduced waste. However, they may also question energy consumption, environmental artificiality, lighting, and technological dependence. Therefore, environmental claims must be specific and comparable. Saying that a product is 'sustainable' is less effective than informing that the system uses water recirculation, reduces losses, enables local production, or maintains safety standards throughout the year.

Schnack *et al.* (2024) and Siegrist *et al.* (2023) broaden this discussion by showing that acceptance of sustainable food technologies depends on readiness, familiarity, risk perception, and benefit evaluation. Thus, hydroponics can be interpreted as a desirable innovation by consumers oriented toward efficiency and sustainability, but as artificial intervention by consumers more sensitive to naturalness.

Naturalness, Artificiality, and Technology Acceptance

Perceived naturalness is a recurrent barrier in technology-intensive production systems. Studies on vertical farming and indoor agriculture show that consumers may associate closed environments, artificial lighting, and automation with lower naturalness, even when they recognize gains in safety and control (Jaeger, 2024; Reis; Friedman; Bitsch, 2023). This tension is central to hydroponic vegetables because the final product is biologically conventional, but its production process distances itself from the image of cultivation in soil.

Califano, Crichton-Fock and Spence (2024), when comparing urban farming, hydroponics, and robotic cultivation, indicate that acceptance varies according to familiarity and the symbolic image of the system. Torres *et al.* (2025), when evaluating lettuce cultivation systems, also point out that more familiar methods or those perceived as less artificial may receive

more favorable evaluations.

This does not mean that technology should be hidden. On the contrary, the review suggests that it should be communicated as an instrument of care, control, and safety, rather than as a replacement for nature. The most promising narrative seems to combine productive precision with tangible benefits: fresh, safe, traceable food, produced with less pressure on resources and with regular supply.

Price, Willingness to Pay, and Purchase Intention

Purchase intention results from the comparison between perceived benefits and perceived sacrifices. Price plays an ambiguous role: it may signal quality, but it may also limit adoption, especially when benefits are not well understood. D'Amico *et al.* (2024) show that quality and sustainability attributes influence willingness to pay for hydroponic tomatoes, but this willingness depends on income, familiarity, and safety perception.

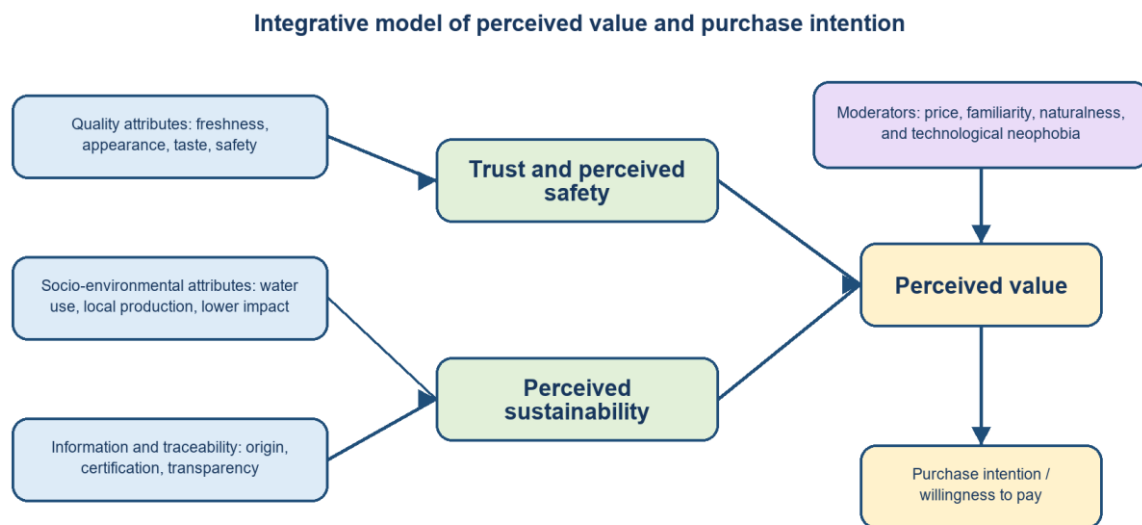
Hartmann *et al.* (2023) contribute by comparing people with lower and higher stated likelihood of purchasing products from vertical farms. This type of evidence suggests that consumers do not form a homogeneous market. Some groups are more open to innovation, while others require sensory evidence, competitive prices, or additional guarantees before buying.

Ezni Balqiah *et al.* (2020) also associate the attractiveness of hydroponics with economic and ecological benefits. This point is relevant because it indicates that environmental appeal must be accompanied by perceived practical advantage. In other words, consumers tend to value sustainability when it translates into personal, family, or economic benefit, and not only into an abstract argument.

Proposed Integrative Model

The synthesis of the studies makes it possible to propose an integrative model in which objective attributes of the product and the production system influence perceived quality, perceived safety, and perceived sustainability. These dimensions are mediated by trust and moderated by price, familiarity, perceived naturalness, and technological neophobia. When consumers understand the benefits and trust the information, these dimensions converge toward perceived value, increasing purchase intention and willingness to pay.

Figure 2. Integrative model of perceived value and purchase intention of hydroponic vegetables



Source: prepared by the authors based on the synthesis of the studies included in the review.

The model also indicates that communication should be segmented. For health-oriented consumers, emphasis may fall on safety, hygiene, and absence of residues. For environmentally sensitive consumers, efficient water use, local production, and waste reduction may be highlighted. For consumers resistant to technology, the strategy should reduce uncertainty, explain the production process, and preserve the association with freshness and sensory quality.

FINAL CONSIDERATIONS

This integrative review demonstrated that perceived value and purchase intention for hydroponic vegetables are formed by multiple dimensions. Perceived quality, food safety, trust in information, perceived sustainability, familiarity with the production system, perceived naturalness, and price act in combination in consumer evaluation.

The findings indicate that sustainability is relevant, but not sufficient to sustain purchase intention. To generate value, it must be translated into verifiable and understandable attributes, such as freshness, traceability, lower resource use, hygiene, regularity, reduction of losses, and health benefits. Trust is the link that connects production claims to the purchase decision.

It is concluded that the market advantage of hydroponic vegetables depends less on the production technology itself and more on the ability to transform this technology into perceived benefits. Hydroponic, indoor, and soilless systems can be accepted when communicated as solutions for safety, quality, and demonstrable sustainability, but they may face resistance when

perceived as artificial, expensive, or unfamiliar.

As limitations, this review used a systematized search in an open bibliographic index and focused on studies published between 2019 and 2026, which may not capture all grey literature or non-indexed local studies. Future research should compare hydroponic, organic, and conventional systems in choice experiments, test point-of-sale communication messages, measure willingness to pay in different segments, and expand Brazilian evidence on trust, traceability, and purchase intention.

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