

Consumer Perceptions of Hydroponic Vegetables: Health, Environmental, and Product Aspects

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Abstract: The market for hydroponic vegetables in Indonesia is in its initial stage, resulting in limited understanding of consumer behavior in this segment. This study aims to explore household consumer perceptions of hydroponic vegetables. Conducted in Kendari, Southeast Sulawesi, the study involved 92 respondents selected through accidental sampling from individuals purchasing vegetables at four small-scale hydroponic farms. Data analysis was performed using descriptive statistics. The results indicate that consumer perceptions of hydroponic vegetables are "high" or "favorable" concerning health and environmental benefits, while perceptions of product characteristics are "fair." Despite the generally positive perceptions, challenges remain regarding price, availability, and points of sale. Further research is required to determine whether the favorable perceptions of hydroponic vegetables are influenced by the Covid-19 pandemic, which has heightened consumer awareness of health and environmental issues.

Keywords: consumer, household, hydroponics, perception, vegetables.

1. Introduction

Hydroponics is a method of growing plants without soil using mineral nutrient solutions in an aqueous solvent [1]. This innovative agricultural technique has garnered significant attention and is becoming an increasingly popular trend due to its efficiency and sustainability. Hydroponic systems can be classified into several types, including nutrient film technique (NFT), deep water culture (DWC), and aeroponics, each offering unique advantages in terms of water usage and growth rates [2]–[4]. The controlled environment in hydroponics allows for year-round production, which can lead to higher yields and consistent quality of produce. As urbanization accelerates and arable land becomes scarce, hydroponics presents a viable solution to meet the rising global demand for fresh vegetables, making it a crucial component of modern agricultural practices, especially in urban areas.

Hydroponic vegetables offer numerous advantages over traditionally grown vegetables, which contribute to their growing popularity [5]–[7]. One of the primary benefits is the significant reduction in water usage, as hydroponic systems can use up to 90% less water compared to conventional soil-based

agriculture. Additionally, hydroponic farming eliminates the need for soil, thereby reducing the risk of soil-borne diseases and pests, leading to healthier plants and lower reliance on pesticides. The controlled environment of hydroponic systems allows for precise management of nutrients, thus ensuring optimal plant growth and often resulting in faster growth cycles and higher yields. Moreover, hydroponic vegetables are typically grown in cleaner environments, which can lead to fresher and potentially more nutritious produce. These advantages collectively make hydroponic farming an attractive option for sustainable agricultural practices and food security.

In Indonesia, the hydroponics industry is gradually gaining momentum as consumers and farmers alike recognize its potential [8]–[10]. The country's tropical climate, coupled with increasing urbanization, changing lifestyles, and growing health awareness, has led to a growing interest in alternative farming methods that can provide consistent and high-quality produce [8]. Hydroponics offers a solution that aligns with Indonesia's need for sustainable agricultural practices, particularly in the context of climate change [11], [12]. Urban areas, in particular, are witnessing a surge in small-scale hydroponic farms, often set up in residential neighborhoods, rooftops, and community gardens. These initiatives not only supply fresh vegetables to local markets but also engage the community in sustainable practices. As a kind of home gardening [13], [14], hydroponics provide additional income and promotes food security. Despite being in the early stages of development, the hydroponics sector in Indonesia shows promising potential for expansion and integration into the broader agricultural landscape.

Vegetables play a crucial role in human health due to their rich content of vitamins, minerals, phytochemical compounds, and dietary fiber [15]. Various leafy vegetables, including spinach, kangkong, caisim, and lettuce, can be cultivated using hydroponic systems [16]. As awareness of the health benefits of green leafy vegetables increases, so does their consumption. In Indonesia, approximately 94.8% of the population consumes vegetables daily, with an average intake of 70.0 grams per person per day [16] with the average consumption of 70.0 g/person/day. This vegetables consumption is considered

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inadequate if compared with the recommended level based on the guidelines of balanced nutrition [17].

Consumer perception towards hydroponic vegetables is generally positive, driven by growing awareness of health and environmental benefits [16], [18]. Consumers appreciate the fact that hydroponic vegetables are often free from harmful pesticides and are grown in controlled environments, which can enhance food safety and nutritional quality. The appeal of hydroponics also extends to its environmental sustainability, as the method significantly reduces water usage and minimizes the need for arable land. Despite these positive perceptions, there are notable challenges that affect consumer acceptance. These include the higher price point of hydroponic vegetables compared to conventionally grown produce and their limited availability in some markets [19], [20]. Additionally, there is a lack of widespread knowledge about hydroponic farming practices and the benefits they offer [10], [19]. Consumers who are well-informed tend to show greater appreciation and willingness to pay a premium for hydroponic vegetables, highlighting the importance of education and marketing efforts in shaping consumer attitudes.

Despite the promising potential and the general favorable perceptions of hydroponic vegetables, there remains a critical need to further investigate consumer attitudes and behaviors towards these products. Understanding consumer perception is essential for the successful market penetration and adoption of hydroponic vegetables. This study aims to address the existing knowledge gap by providing insights into household consumers' perception towards hydroponic vegetables. The findings can inform producers, retailers, and policymakers about the factors that influence consumer decisions, thereby enabling them to develop targeted strategies to enhance market acceptance.

2. Materials and Methods

This study was conducted in Kendari, the capital city of Southeast Sulawesi province, to examine consumer perceptions towards hydroponic vegetables. A survey methodology was employed, involving direct interviews with a sample of 92 respondents. The respondents were selected using an accidental sampling method, targeting consumers who purchased hydroponic vegetables from four different small-scale hydroponic farms in the area. Researchers positioned themselves at the entrances of these farms to administer questionnaires to consumers as they entered.

The questionnaire utilized in this study was designed to capture respondents' perceptions across three key aspects: health benefits, environmental impact, and their perception of the hydroponic vegetable products. Responses were recorded on a five-point Likert scale, ranging from "strongly disagree" to "strongly agree," allowing for nuanced insights into consumer

perception [21], [22].

To analyze the data, descriptive statistics were employed, focusing on scoring to calculate the average responses for each of the three perception aspects. This approach provided a comprehensive overview of consumer attitudes towards hydroponic vegetables, highlighting areas of favorable perception as well as potential challenges.

3. Results and Discussion

A. Perception Towards Health

The mean values shown in Table 1 for the dimensions of health consciousness show that respondents are health conscious and aware of good attributes of hydroponic vegetables. The mean values range from 4.05 to 4.18 or are in the high category. This result implies that respondents perceived hydroponic vegetables as being "high" or good in terms of some proposed health indicators. Respondents considered hydroponic vegetables (i) contain nutrients that are good for health, (2) are fresher because they are directly and freshly harvested, (3) safer to eat because they contain less chemicals, and (4) more natural, which is good for the body. This result agrees to findings in numerous studies that perceived food healthfulness is an important factor that determines overall dietary choices, although it may be less important than other attributes such as taste, price, and packaging in influencing purchasing decisions [18], [23], [24].

The perception that hydroponic vegetables contain nutrients that are beneficial for health received a mean value of 4.05, which falls into the high category. This suggests that consumers recognize the nutritional advantages of hydroponic produce. They seem to appreciate that these vegetables can be grown with precise nutrient management, resulting in better nutritional profiles compared to conventionally grown vegetables.

The aspect of freshness, with a mean value of 4.13, also ranks high among respondents. Consumers perceive hydroponic vegetables as fresher, primarily because these vegetables are often harvested directly from controlled environments and sold promptly. This immediate farm-to-table approach minimizes the time between harvest and consumption and preserves the vegetables' freshness and nutritional content.

Safety, a crucial factor in consumer food choices, is another area where hydroponic vegetables are highly regarded. The mean value for the perception that hydroponic vegetables are safer due to lower chemical use is 4.18, the highest among the health-related aspects surveyed. This indicates a strong consumer awareness and appreciation of the reduced pesticide and herbicide usage in hydroponic farming, which directly translates into a perception of safer, healthier food options.

The belief that hydroponic vegetables are more natural and thus healthier for the body also obtained a high mean value of 4.10. This perception is likely influenced by the controlled and

Table 1

Mean values of consumer perception towards health consciousness aspects of hydroponic vegetables			
No.	Health Consciousness	Mean Value	Category
1	Hydroponic vegetables contain nutrients that are good for health.	4.05	High
2	Hydroponic vegetables are fresher because they are directly or freshly harvested.	4.13	High
3	Hydroponic vegetables are safer to eat because they contain less chemicals	4.18	High
4	Hydroponic vegetables are more natural, making them healthier for the body.	4.10	High

often organic-like conditions under which hydroponic vegetables are grown, free from many of the pollutants and contaminants associated with soil-based agriculture.

Overall, the results indicate a robust consumer belief in the health benefits of hydroponic vegetables. This favorable perception is a significant driver for the potential market growth of hydroponic produce, suggesting that consumers are not only aware of but also value the health advantages offered by hydroponic products. These insights underline the importance for producers and marketers to highlight health benefits in their promotional strategies to further enhance consumer acceptance and demand for hydroponic vegetables.

Favorable perception of health aspect of hydroponic vegetables is related to the characteristics of hydroponic farming. Hydroponic farm, plants are cultivated in largely controlled environment in which all their nourishments are distributed through nutrient-enriched water which does not depend on soil or precipitation. Unlike vegetables grown conventionally in rural areas, harvested previous days, and transported to urban market through intermediaries, hydroponic vegetables can be consumed immediately after being harvested, making them fresher when consumed. Furthermore, respondents tend to believe that hydroponic vegetables are safer because they use less pesticides and chemicals which could have adverse effect on human body. In spite of the absence of, or less usage of pesticides and chemicals, hydroponic crops does not have much pest and disease attack, leading to clean and fresh produce. Indeed, controlled environment enables hydroponics farming to reduce and even avoid issues related to weather, pest and disease, soil fertility, flood, and water, which are common in soil-based agriculture [25]–[27].

The findings of this study align with the results of numerous previous studies. For instance, Salleh *et al.* [28] demonstrated that health consciousness significantly influences customer purchase intentions regarding organic food products. Similarly, research conducted by Wier and Calverley [29] indicated that health benefits are frequently cited as the primary motivation for purchasing organic food products. These studies corroborate our findings that health-related factors play a crucial role in shaping consumer perceptions and purchasing behaviors towards hydroponic vegetables. This consistency across studies underscores the importance of health consciousness in the broader context of consumer behavior towards alternative and sustainable food sources.

B. Perception Towards Environmental Concern

The analysis of consumer perception towards the environmental benefits of hydroponic vegetables also demonstrates a positive outlook, with high mean values across various environmental concern aspects (Table 2).

Firstly, the statement "I care about environmental conservation" received a mean value of 4.03, indicating a high

level of environmental awareness among respondents. This suggests that consumers in Kendari are generally conscientious about environmental issues and likely consider these factors when making purchasing decisions. Such a predisposition aligns well with the sustainable attributes of hydroponic farming.

Secondly, the importance of environmental care and preservation in determining food purchases received a mean value of 3.80, which is also categorized as high. This finding underscores that environmental considerations are a significant factor for consumers when selecting food products. It highlights that the environmental friendliness of hydroponic vegetables can be a compelling selling point, as consumers who prioritize sustainability are more likely to choose products that align with their values.

Lastly, the perception that the production process of hydroponic vegetables is more environmentally friendly, with a mean value of 3.97, further emphasizes consumer recognition of the sustainability benefits associated with hydroponics. Respondents acknowledge that hydroponic farming methods, which typically involve reduced water usage and minimal impact on soil and air quality, are advantageous over traditional farming practices. This perception is crucial, as it validates the potential of hydroponic vegetables to appeal to environmentally conscious consumers.

In summary, the high mean values in environmental concern aspects indicate that consumers not only care about the environment but also perceive hydroponic vegetables as a more sustainable option. This favorable perception can be used by producers and marketers to position hydroponic vegetables as an eco-friendly choice, thus attracting a segment of the market that is increasingly motivated by sustainability considerations. The positive environmental perception augments the overall appeal of hydroponic vegetables and supports their potential for broader market acceptance.

Vegetables grown hydroponically are considered more environmentally friendly because the nutrient-enriched water is reused, thus there are no surface run-offs. Hydroponic system uses less water, space, and land so that it reduces the pressure to the environment. It does not emit toxins to the nearby environment. It also eliminates the need for transporting farm products thousands of miles, which puts a tremendous load on the environment. In addition, many farmers are also not using packaging, further making hydroponic farming environmentally friendly.

The study conducted by Davies, Titterington, and Cochrane [30] indicates that health and environmental concerns are the primary motivations for purchasing organic produce. Globally, consumers are showing a growing interest in environmentally friendly fresh vegetables, driven by the well-documented inverse relationship between vegetable consumption and the risk of various chronic and degenerative diseases [31], [32].

Table 2
Mean values of consumer perception towards environmental aspects of hydroponic vegetables

No.	Environmental Concern	Mean Value	Category
1	I care about environmental conservation.	4.03	High
2	Aspects of care and environmental preservation are very important in determining the food I will buy.	3.80	High
3	The production process of hydroponic vegetables is more environmentally friendly than ordinary vegetables.	3.97	High

Table 3
Mean values of consumer perception towards product attributes of hydroponic vegetables

No.	Perception of products	Mean Value	Category
1	Hydroponic vegetables are better than conventionally produced ones in taste, safety, and freshness	3.68	High
2	Hydroponic vegetables are always available throughout the year	3.58	Fair
3	Price is affordable	3.30	Fair
4	Farm or selling outlet is easily accessible	3.42	Fair
5	Home delivery is available	3.32	Fair
6	Farm operator or owner are friendly and responsive to customers	3.27	Fair
7	Information about hydroponic vegetables from various sources is sufficient	3.55	Fair

C. Perception Towards Product

The perception of hydroponic vegetables as products exhibits a mix of high and fair ratings (Table 3), reflecting varied consumer attitudes towards different product attributes.

The statement that hydroponic vegetables are better than conventionally produced ones in terms of taste, safety, and freshness obtained a mean value of 3.68, indicating a high level of consumer satisfaction in these areas. This suggests that consumers perceive hydroponic vegetables as superior to their conventionally grown counterparts, particularly valuing their taste, the safety derived from reduced chemical use, and the freshness associated with direct-from-farm purchases.

Conversely, the availability of hydroponic vegetables throughout the year received a mean value of 3.58, which falls into the fair category. While consumers acknowledge the potential for year-round availability inherent in controlled environment agriculture, there appears to be room for improvement in ensuring consistent supply to meet consumer demand at all times.

Affordability, with a mean value of 3.30, is another area where perceptions are only fair. This indicates that while some consumers may find the price of hydroponic vegetables acceptable, a significant portion perceives them as relatively expensive. Price sensitivity could be a barrier to broader adoption, necessitating efforts to either reduce costs or better communicate the value proposition of hydroponic vegetables to justify their price.

Accessibility to farms or selling outlets also received a fair rating, with a mean value of 3.42. This suggests that while hydroponic vegetables are somewhat accessible, there are challenges in terms of distribution and convenience for consumers. Enhancing the retail network and ensuring easier access to selling points could improve consumer perceptions in this area.

Home delivery services were rated with a mean value of 3.32, indicating a fair perception. All hydroponics farms have used digital marketing to market their produce [8], and established partnerships with mobile technology companies such as Grab and Gojek to provide home-delivery services to consumers. The availability of home delivery is an important convenience factor, and improving these services could enhance overall consumer satisfaction and broaden the market reach of hydroponic vegetables.

Interactions with farm operators or owners received a mean value of 3.27, the lowest among the product-related aspects, reflecting a fair perception. While consumers find farm operators to be somewhat friendly and responsive, enhancing customer service and building stronger relationships could

positively impact consumer experiences and perceptions.

Lastly, the sufficiency of information about hydroponic vegetables from various sources was rated with a mean value of 3.55, indicating a fair perception. This suggests that consumers feel moderately informed but may benefit from more comprehensive and accessible information about hydroponic farming practices and the benefits of hydroponic vegetables.

In summary, while the perception of hydroponic vegetables in terms of taste, safety, and freshness is high, other product-related aspects such as price, accessibility, home delivery, customer service, and information availability are perceived as fair. Addressing these areas could enhance overall consumer satisfaction and support the growth of the hydroponic vegetable market.

4. Conclusion

This study provides valuable insights into consumer perceptions of hydroponic vegetables in Kendari, Southeast Sulawesi, focusing on three key aspects: health, environmental concern, and product attributes. The findings indicate a generally positive consumer outlook, with significant implications for the market potential and strategic promotion of hydroponic produce.

Consumers in Kendari exhibit a strong perception of the health benefits of hydroponic vegetables. High mean values across various health-related aspects suggest that consumers recognize the nutritional advantages, freshness, and safety of hydroponically grown produce. This favorable perception underscores the importance of emphasizing health benefits in marketing strategies to enhance consumer acceptance and demand.

Environmental concern is another critical factor driving consumer perception. The high mean values indicate that consumers are aware of and value the environmental sustainability of hydroponic farming. They appreciate the reduced water usage, minimal chemical inputs, and overall lower environmental footprint compared to conventional agriculture. Promoting the eco-friendly nature of hydroponic vegetables can attract environmentally conscious consumers and support sustainable agricultural practices.

However, the perception of hydroponic vegetables as products presents a mixed picture. While consumers view the taste, safety, and freshness of hydroponic vegetables positively, other attributes such as price, availability, accessibility, home delivery services, customer service, and information sufficiency receive only fair ratings. These findings highlight the need for improvements in distribution networks, affordability, customer relations, and consumer education to enhance overall satisfaction and market growth.

While the health and environmental benefits of hydroponic vegetables are well-recognized by consumers, addressing the fair perceptions related to product attributes is essential for broader market acceptance. Efforts to improve affordability, accessibility, customer service, and information dissemination will be crucial in leveraging the positive health and environmental perceptions to drive the expansion of the hydroponic vegetable market. Future research should continue to explore these dimensions, particularly in different regions and demographic segments, to provide a more comprehensive understanding of consumer behavior and preferences towards hydroponic vegetables.

References

- [1] K. Gole, T. Nalange, and P. Gaikwad, "Consumers Perception towards Hydroponically Grown Residue-Free Vegetables," *Our Herit.*, vol. 68, no. 30, pp. 8215–8229, 2020.
- [2] B. Manggala, M. Debra, C. Chaichana, W. N. H. Syahputra, and M. Lutfi, "Effects of Various Hydroponic Systems in Increasing Caisim (*Brassica Chinensis* L.) Productivity Under LED Grow Light," *Int. J. Food, Agric. Nat. Resour.*, vol. 4, no. 2, pp. 53–58, Jun. 2023.
- [3] A. M. Al-Shrouf, "Hydroponics, Aeroponic and Aquaponic as Compared with Conventional Farming," *Glob. Soc. Sci. Res. Res.*, vol. 27, no. 1, pp. 247–255, 2017.
- [4] B. Frasetya, K. Harisman, and N. A. H. Ramdaniah, "The effect of hydroponics systems on the growth of lettuce," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1098, no. 4, p. 042115, Mar. 2021.
- [5] S. Khan, A. Purohit, and N. Vadsaria, "Hydroponics: current and future state of the art in farming," *J. Plant Nutr.*, vol. 44, no. 10, pp. 1515–1538, Jun. 2021.
- [6] S. Jan *et al.*, "Hydroponics – A Review," *Int. J. Curr. Microbiol. Appl. Sci.*, vol. 9, no. 8, pp. 1779–1787, Aug. 2020.
- [7] I. Prayoga and R. A. Putra, "Hydroponic Technology in Agriculture Industry," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 879, no. 1, p. 012130, Jul. 2020.
- [8] L. O. Sarfan, H. Saediman, and W. O. Yusria, "Analisis Pemanfaatan Digital Marketing Sebagai Media Pemasaran Sayuran Hidroponik Di Kota Kendari," *Innov. J. Soc. Sci. Res.*, vol. 4, no. 3, pp. 1678–1696, 2024.
- [9] B. Foster, F. Reyta, and M. D. Johansyah, "Hydroponic Training to Improve Community Living Standards in Densely Populated and Weak Economies," *Budapest Int. Res. Critics Inst. Humanit. Soc. Sci.*, vol. 4, no. 1, pp. 1569–1577, Mar. 2021.
- [10] A. Putri *et al.*, "Buyer Decisions on Hydroponic Vegetable Products," *E3S Web Conf.*, vol. 374, p. 00005, Mar. 2023.
- [11] H. Saediman, L. O. Lasmin, M. A. Limi, U. Rianse, and L. Geo, "Rice Farmers' Perception of Climate Variability in South Konawe District of Southeast Sulawesi," *Int. J. Sci. Technol. Res.*, vol. 9, no. 2, pp. 3128–3132, 2020.
- [12] H. Saediman, M. A. Limi, Y. Indarsyih, S. Abdullah, and W. O. Yusria, "Rice farmers' adaptation practices to climate change: a case of Konda subdistrict in Southeast Sulawesi," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 724, p. 012102, 2021.
- [13] N. Nasrida, H. Saediman, I. S. Rianse, and H. Hidrawati, "Contribution of Home Gardening to Household Vegetable Consumption During COVID-19 Pandemic," *Int. J. Res. Eng. Sci. Manag.*, vol. 6, no. 5, pp. 5–9, 2023.
- [14] H. Saediman *et al.*, "The contribution of home food gardening program to household food security in Indonesia: A review," *WSEAS Trans. Environ. Dev.*, vol. 17, pp. 795–809, 2021.
- [15] T. G. Ulger, A. N. Songur, O. Çirak, and F. P. Çakıroğlu, "Role of Vegetables in Human Nutrition and Disease Prevention," in *Vegetables - Importance of Quality Vegetables to Human Health*, M. Asaduzzaman and T. Asao, Eds., InTech Open, 2018, pp. 7–32.
- [16] P. C. Ayu, R. B. M. I. Fathoni, and R. R. Siregar, "Indicators of customers in selecting hydroponic green leafy vegetables (Study case: millennials in North Sumatera)," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 782, p. 022054, Jun. 2021.
- [17] Hermina and S. Prihatini, "Gambaran Konsumsi Sayur dan Buah Penduduk Indonesia dalam Konteks Gizi Seimbang: Analisis Lanjut Survei Konsumsi Makanan Individu (SKMI) 2014," *Bul. Penelit. Kesehat.*, vol. 44, no. 3, pp. 205–218, 2016.
- [18] P. T. T. Huong, A. P. Everaarts, J. J. Neeteson, and P. C. Struik, "Vegetable production in the Red River Delta of Vietnam. I. Opportunities and constraints," *NJAS Wageningen J. Life Sci.*, vol. 67, no. 1, pp. 27–36, Dec. 2013.
- [19] T. Ezni Balqiah, A. Pardyanto, R. Dewi Astuti, and S. Mukhtar, "Understanding how to increase hydroponic attractiveness: Economic and ecological benefit," *E3S Web Conf.*, vol. 211, p. 01015, Nov. 2020.
- [20] Y. Yano, T. Nakamura, S. Ishitsuka, and A. Maruyama, "Consumer Attitudes toward Vertically Farmed Produce in Russia: A Study Using Ordered Logit and Co-Occurrence Network Analysis," *Foods*, vol. 10, no. 3, p. 638, Mar. 2021.
- [21] S. Surni and H. Saediman, "Gender participation in palm sugar processing in Kolaka district of Southeast Sulawesi," *WSEAS Trans. Environ. Dev.*, vol. 16, pp. 34–39, 2020.
- [22] M. S. Mboe, H. Saediman, A. Rifay, T. Utami, and A. O. Purnomo, "The Use of Mobile Phones Among Sweet Potato Farmers for Agricultural Information in Ranomeeto Subdistrict in Southeast Sulawesi," *Int. J. Res. Eng. Sci. Manag.*, vol. 7, no. 6, pp. 208–213, 2024.
- [23] J. M. Wills, S. Storcksdieck genannt Bonsmann, M. Kolka, and K. G. Grunert, "European consumers and health claims: attitudes, understanding and purchasing behaviour," *Proc. Nutr. Soc.*, vol. 71, pp. 229–236, May 2012.
- [24] P. C. Ayu, R. B. M. I. Fathoni, and R. R. Siregar, "Indicators of customers in selecting hydroponic green leafy vegetables (Study case: millennials in North Sumatera)," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 782, no. 2, p. 022054, Jun. 2021.
- [25] S. Surni, H. Saediman, F. Wulandari, M. Zani, L. Yunus, and S. A. A. Taridala, "Profitability and constraints of small-scale tomato production in Baubau municipality of Southeast Sulawesi," *WSEAS Trans. Environ. Dev.*, vol. 16, pp. 219–225, 2020.
- [26] H. Saediman, Y. Indarsyih, S. Abdullah, S. A. Fyka, and I. S. Mboe, "Assessing major drivers of crop shifting from rice to horticultural production: a case of Landono sub-regency in Southeast Sulawesi," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 724, p. 012006, 2021.
- [27] L. Geo and H. Saediman, "Rice farming to brick production: What are major drivers of livelihood shift?," *Biosci. Res.*, vol. 16, no. 4, pp. 3640–3647, 2019.
- [28] M. M. Salleh, S. M. Ali, E. H. Harun, M. A. Jalil, and M. R. Shaharudin, "Consumer's Perception and Purchase Intentions Towards Organic Food Products: Exploring Attitude Among Academician," *Can. Soc. Sci.*, vol. 6, no. 6, pp. 119–129, 2010.
- [29] M. Wier and C. Calverly, "Market Penetration for Organic Food Products in Europe," *Br. Food J.*, vol. 104, no. 1, pp. 45–62, 2002.
- [30] A. Davies, A. J. Titterton, and C. Cochrane, "Who Buy Organic Food Products? A Profile of the Purchasers of Organic Food Products in Northern Ireland," *Br. Food J.*, vol. 97, no. 10, pp. 17–23, 1995.
- [31] P. M. Kris-Etherton *et al.*, "Bioactive compounds in foods: their role in the prevention of cardiovascular disease and cancer," *Am. J. Med.*, vol. 113, no. 9, pp. 71–88, Dec. 2002.
- [32] A. Aires, "Hydroponic Production Systems: Impact on Nutritional Status and Bioactive Compounds of Fresh Vegetables," in *Vegetables - Importance of Quality Vegetables to Human Health*, InTech, 2018.