

Assessing Postharvest Handling and Consumer Willingness to Pay for Carrots in Tawangmangu

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ABSTRACT

Background: Suboptimal postharvest handling at an upstream level remains an important challenge in maintaining the quality and economic value of horticultural products before reaching final markets. In traditional supply chains, limited logistical infrastructure, non-standardized handling, and subjective grading practices may increase vulnerability to quality deterioration.

Purpose: This study aims to assess postharvest handling practices and potential points of quality deterioration along the carrot supply chain, as well as consumer quality perceptions and stated willingness to pay (WTP) for improved physical quality in the study area. The study was limited to selected supply-chain actors and consumers in that area.

Design/methodology/approach: An exploratory descriptive survey was conducted in Blumbang Village, Tawangmangu District, Karanganyar Regency, from July to August 2026. Thirty respondents were purposively selected, comprising 10 farmers, 10 collectors, and 10 consumers. Data was collected through questionnaires, interviews, and field observations and analyzed using frequencies and percentages.

Findings/Results: Potential postharvest vulnerabilities were identified during mechanical washing, transportation, and storage. Mechanical washing with rotary washers and the use of flexible mesh-bag packaging were potential concerns for physical protection. Descriptive results showed that 60.0% of consumers preferred very clean carrots, while 50.0% reported that they would reject carrots with visible physical defects. During household storage, 60.0% reported softening or wilting and 30.0% reported slimy decay. Regarding willingness to pay, 60.0% of consumers stated that they were willing to pay an additional IDR 500–1,000/kg for carrots with better physical quality.

Conclusion: The findings indicate that washing, packaging, transportation, and storage practices represent potential points of quality vulnerability in the local carrot supply chain. Consumer responses also indicate potential economic value associated with better physical quality, as reflected in the stated WTP of part of the consumers surveyed. However, the findings are limited to the selected respondents and the study area and should not be generalized directly to other carrot-producing regions.

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INTRODUCTION

Horticultural commodities, particularly vegetables such as carrots (*Daucus carota* L.), are highly perishable and susceptible to quality deterioration during postharvest handling, distribution, and storage (Kader, 2002; Kitinoja & Kader, 2015). In fresh-produce supply chains, inadequate handling, limited postharvest infrastructure, and inappropriate storage conditions may increase the risk of physical and physiological quality losses before products reach consumers. Studies on carrots have shown that storage temperature can affect weight loss, respiration rate, and disease development during storage (Heltoft et al., 2026), while research on carrot supply chains has also identified postharvest handling as an important component of product quality and distribution performance (Indrianto & Prihtanti, 2023; Djarkasi et al., 2026). These findings indicate that quality risks may arise at different stages of the supply chain, making the identification

of potential deterioration points relevant to local carrot distribution systems.

Blumbang Village, Tawangmangu District, Karanganyar Regency, is a highland area where carrot production forms part of local agricultural activity. Carrots produced in the area are handled through a relatively short supply chain involving farmers, collectors, and subsequent market actors. Previous studies of carrot supply chains in Indonesia have described the roles of farmers, collectors, transportation, and marketing activities in determining the movement and distribution of carrots (Indrianto & Prihtanti, 2023). At the farm and collector levels, postharvest activities include harvesting, washing, sorting, grading, packaging, transportation, and temporary storage. These activities may expose carrots to different forms of physical stress. Research on carrot supply chains has documented physical damage associated with postharvest handling, including abrasion, cracking, bruising, and other mechanical damage (Djarkasi et al., 2026). Packaging is

also relevant because appropriate packaging can provide protection against physical stress and help maintain product quality during handling and storage (Amin et al., 2021). Therefore, examining actual handling practices and the conditions associated with potential physical damage can provide useful information on postharvest quality vulnerability at the upstream level.

Postharvest quality is also relevant from the consumer perspective because physical characteristics influence how fresh vegetables are evaluated and selected. Consumer studies have shown that attributes such as appearance, cleanliness, freshness, size, price, and other visible product characteristics can contribute to vegetable preferences (Prisanti et al., 2024; Yang et al., 2021). Research on organic vegetables in Indonesia has further demonstrated that consumers may express different levels of willingness to pay for products with quality or production attributes (Hasanah & Yanuar, 2024; Banjarnahor & Setiadi, 2024). Studies specifically examining willingness to pay for vegetables have also reported that perceived product quality can be associated with consumers' stated price premiums (Kendiza et al., 2025; Noor et al., 2024). Thus, consumer responses can complement upstream observations by indicating which aspects of carrot quality are considered important in the marketplace.

Although postharvest handling and consumer valuation have each been examined in previous studies, they are generally discussed from different perspectives. Postharvest studies have focused on handling practices, physical damage, packaging, and storage conditions (Amin et al., 2021; Djarkasi et al., 2026; Heltoft et al., 2026), whereas consumer-oriented studies have examined preferences and willingness to pay for vegetables based on product characteristics and perceived quality (Banjarnahor & Setiadi, 2024; Hasanah & Yanuar, 2024; Kendiza et al., 2025; Noor et al., 2024; Prisanti et al., 2024). However, descriptive evidence that considers potential postharvest vulnerability together with consumer quality perceptions and stated willingness to pay within the same local carrot supply-chain context remains limited. Examining these perspectives together can provide a more integrated description of how upstream handling conditions and downstream consumer valuation relate within a local supply chain.

The present study addresses this gap by examining the carrot supply chain in Blumbang Village, Tawangmangu, Karanganyar, from both upstream and downstream perspectives. The study describes postharvest handling practices, identifies potential points of physical quality deterioration, and examines consumer quality perceptions, household storage practices, and stated willingness to pay (WTP) for carrots with improved physical quality. Because the study employs an exploratory descriptive design and purposive sampling, it does not test formal statistical hypotheses or estimate causal relationships. Instead, it integrates observations from farmers and collectors with consumer responses to provide context-specific empirical evidence on postharvest vulnerability and consumer-valued carrot quality attributes. The findings are intended to contribute to understanding postharvest handling and

consumer valuation in the local carrot supply chain, with interpretation limited to the study population and area.

Based on the identified research gap, this study aims to: (1) describe the demographic characteristics of carrot supply-chain actors in Blumbang Village, Tawangmangu; (2) characterize postharvest handling practices and identify potential points of physical quality deterioration along the distribution process; and (3) describe consumer quality perceptions, household storage practices, and stated willingness to pay (WTP) for carrots with improved physical quality.

METHODS

This study employed an exploratory descriptive quantitative approach. The research was conducted in Blumbang Village, Tawangmangu District, Karanganyar Regency, Central Java Province, Indonesia, from July to August 2026. The study area was purposively selected because it was a carrot-producing area in the highlands of Karanganyar. Primary data were obtained from 30 respondents consisting of 10 carrot farmers, 10 collectors, and 10 final consumers. The three respondent groups were included to capture complementary perspectives from carrot producers, postharvest handlers, and consumers. Secondary data were obtained from relevant scientific publications, institutional reports, and statistical information to provide supporting information on carrot production, postharvest handling, supply chains, and consumer preferences.

Primary data were collected through structured interviews, questionnaires, and direct field observations. Farmers and collectors were selected purposively based on their involvement in carrot production and postharvest handling, while consumers were selected based on their experience purchasing carrots for household consumption. The questionnaire for farmers and collectors covered harvesting practices, postharvest washing, sorting and grading, packaging, transportation, storage, and perceived postharvest problems. The consumer questionnaire covered purchasing habits, quality selection criteria, household storage practices, types of deterioration observed during storage, and willingness to pay for better-quality carrots. Data collected from farmers and collectors included demographic characteristics and postharvest practices covering harvesting, washing, sorting, grading, packaging, transportation, and storage. Attention was paid to mechanical washing using rotary washers, flexible mesh packaging (*tictas*), and visible physical damage. Field observations focused on the handling activities and conditions associated with harvesting, washing, sorting, grading, packaging, transportation, and storage, including visible physical damage and the use of mechanical washing equipment and flexible mesh packaging (*tictas*). Consumer data included demographic characteristics, perceptions of carrot quality, household storage practices, types of deterioration observed during storage, and willingness to pay (WTP) for better-quality carrots. Consumer quality perceptions included cleanliness, physical appearance, freshness, and visible defects.

The collected data were tabulated and analyzed descriptively using frequencies and percentages. The analysis covered respondent characteristics, postharvest handling practices, observed physical and physiological deterioration, consumer quality perceptions, household storage practices, and WTP responses. For each category, the percentage was calculated based on the number of respondents selecting a particular response relative to the total number of respondents in the relevant group. The percentage was calculated using the formula: $P = (n/N) \times 100$, where P is the percentage, n is the number of respondents selecting a response category, and N is the total number of respondents in the relevant respondent group. The results were presented in tables and interpreted descriptively to identify patterns in postharvest handling and consumer responses. The WTP analysis focused on the distribution of stated additional payment amounts and did not involve econometric estimation or inferential statistical testing.

The framework of thought was developed by integrating the upstream and downstream perspectives of the carrot supply chain. Postharvest handling practices from harvesting through storage could create potential points of physical and physiological quality deterioration, while the resulting product attributes could influence consumer perceptions and stated willingness to pay. Therefore, field observations and interviews with farmers and collectors were integrated with consumer survey responses to provide a descriptive assessment of postharvest handling and consumer-valued carrot quality.

RESULTS

The socio-demographic profile of the respondents was summarized in Table 1. The sample consisted of 30 individuals, divided equally into three groups: farmers, collectors, and consumers ($n = 10$ each). In terms of gender, most respondents were male (60.0%), mainly represented by the farmer and collector groups, while the consumer group

was predominantly female (90.0%). Regarding age, half of the respondents (50.0%) were in the 30–50 years age group, indicating that a substantial proportion of respondents were within the economically active age range. In terms of formal education, the respondents had diverse educational backgrounds. Elementary school was the most common education level (40.0%), particularly among farmers, whereas respondents with higher education were found only in the consumer group (6.7%). Regarding business experience, 53.3% of respondents had 10–20 years of experience in their respective activities, indicating that a substantial proportion of the respondents were considerably experienced in their fields.

The postharvest handling practices and their corresponding potential quality risks along the Blumbang carrot supply chain were presented in Table 2. The assessment covered seven postharvest stages, from harvesting to storage. At the harvesting stage, carrots were manually harvested at 90–100 days after planting, with fractures and cracking identified as potential physical risks. During washing, farmers and collectors used a mechanical rotary washer with a capacity of approximately 200 kg per 5 minutes. This operation was associated with potential epidermal scratching and abrasion. The sorting and grading stages were primarily based on visual assessment, with sorting involving post-washing inspection, and grading based on physical characteristics and size, indicating potential variation in quality classification.

In the subsequent stages, carrots were packaged in flexible synthetic mesh bags, locally known as tictas, which provided limited protection against impact and compression. Transportation using pick-up trucks and motorcycles exposed the produce to vibration and physical shocks. At the storage stage, no dedicated cold storage was observed because carrots were generally distributed shortly after handling. This condition may have increased the potential for moisture loss and physiological deterioration. Overall, Table 2 identified several potential points of physical and physiological quality vulnerability along the local carrot supply chain.

Table 1. Socio-demographic characteristics of respondents (N = 30)

Characteristic	Category	Farmers (n = 10)	Collectors (n = 10)	Consumers (n = 10)	Total (N = 30)	Percentage (%)
Gender	Male	8	9	1	18	60.0
	Female	2	1	9	12	40.0
Age group	<30 years	0	0	3	3	10.0
	30–50 years	3	7	5	15	50.0
	>50 years	7	3	2	12	40.0
Education level	Elementary school	7	4	1	12	40.0
	Junior high school	0	3	2	5	16.7
	Senior high school	3	3	5	11	36.7
	Higher education	0	0	2	2	6.7
Business experience	<10 years	1	1	4	6	20.0
	10–20 years	6	7	3	16	53.3
	>20 years	3	2	3	8	26.7

Consumer quality perceptions, household storage practices, and stated willingness to pay for quality improvements were presented in Table 3 ($n = 10$). Regarding purchase frequency, most consumers purchased carrots once a week (60.0%), while the remaining 40.0% purchased carrots 2–3 times per week. In terms of cleanliness preference, 60.0% of consumers preferred very clean carrots, while 40.0% preferred moderately clean carrots. Regarding the occurrence of physical defects in the market, 50.0% of consumers reported observing defects occasionally and 30.0% reported observing them frequently. In response to physical defects, 50.0% of consumers reported that they would reject or refuse to purchase damaged carrots, while 40.0% would consider purchasing them at a discounted price.

At the household level, 50.0% of respondents stored carrots in a refrigerator using a closed container, whereas 30.0% stored them at room temperature without a closed container. The dominant form of deterioration reported during household storage was softening or wilting (60.0%), followed by slimy decay (30.0%). Regarding stated willingness to pay, 60.0% of

consumers stated that they were willing to pay an additional IDR 500–1,000 per kg for carrots with better physical quality, while 20.0% were unwilling to pay an additional premium. The remaining 20.0% indicated that their willingness to pay depended on the physical condition of the carrots.

The distribution of consumer preferences for carrot cleanliness was illustrated in Figure 1. Most consumers (60.0%) preferred very clean carrots, while 40.0% preferred moderately clean carrots. This distribution indicated that cleanliness was a commonly considered physical quality attribute among the surveyed consumers.

The dominant forms of carrot deterioration reported during household storage were presented in Figure 2. Softening or wilting was the most frequently reported form of deterioration (60.0%), followed by slimy decay (30.0%) and other forms of deterioration (10.0%). These responses indicated that softening or wilting was the most frequently reported form of deterioration during household storage among the surveyed consumers.

Table 2. Postharvest handling practices and potential quality risks in the Blumbang carrot supply chain

Postharvest stage	Observed practice	Potential quality risk
Harvesting	Manual pulling at 90–100 days after planting	Fractures and cracking
Washing	Mechanical rotary washer/drum (~200 kg/5 min)	Epidermal scratches and abrasion
Sorting	Visual inspection after washing	Subjective quality assessment
Grading	Classification into Grades A–D based on appearance and size	Lack of uniform numerical criteria
Packaging	Flexible synthetic mesh bags (tictas)	Limited protection against impact and compression
Transportation	Pick-up trucks and motorcycles	Vibration and physical shocks
Storage	Rapid distribution; no dedicated cold storage observed	Potential moisture loss and physiological deterioration

Table 3. Consumer quality perceptions, household storage practices, and stated willingness to pay ($n = 10$)

Variable	Response category	n	Percentage (%)
Purchase frequency	1 time/week	6	60.0
	2–3 times/week	4	40.0
	>3 times/week	0	0.0
Cleanliness preference	Very clean	6	60.0
	Moderately clean	4	40.0
Defect frequency in market	Occasionally	5	50.0
	Frequently	3	30.0
	Rarely/Never	2	20.0
Response to physical defects	Reject/refuse to buy	5	50.0
	Purchase with price discount	4	40.0
	Accept if internal quality is good	1	10.0
Household storage	Refrigerator with closed container	5	50.0
	Open room temperature	3	30.0
	Refrigerator without container	2	20.0
Dominant deterioration	Softening/wilting	6	60.0
	Slimy decay	3	30.0
	Other deterioration	1	10.0
Stated WTP	IDR 500–1,000/kg premium	6	60.0
	Unwilling to pay premium	2	20.0
	Depending on physical condition	2	20.0

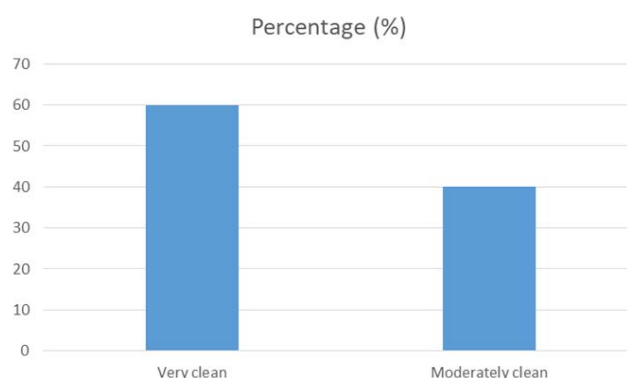


Figure 1. Consumer preference for carrot cleanliness (%)

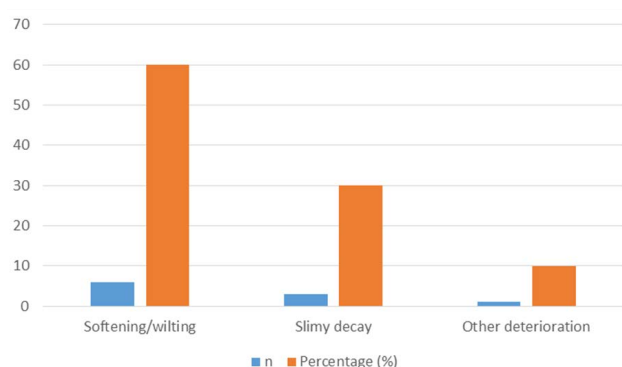


Figure 2. Dominant forms of carrot deterioration during household storage (%)

Postharvest Handling and Potential Quality Vulnerability

The findings indicated that several stages of the Blumbang carrot supply chain represented potential points of physical quality vulnerability, particularly during washing, packaging, and transportation. Mechanical washing using rotary equipment was identified as a potential source of epidermal scratches and abrasion, while flexible mesh-bag packaging and transportation using pick-up trucks and motorcycles may have exposed carrots to impact, compression, and vibration. These observations were consistent with the general principle that fresh horticultural commodities are susceptible to physical injury during postharvest handling, which can contribute to subsequent quality deterioration (Kader, 2002; Djarkasi et al., 2026).

The observed vulnerability during mechanical washing was consistent with findings from carrot supply-chain research showing that postharvest handling activities can be associated with physical damage to carrot surfaces, including abrasion, cracking, bruising, and other forms of mechanical injury (Djarkasi et al., 2026). This provided a relevant basis for interpreting mechanical washing as a potential vulnerability point in the present supply chain. However, the present study was descriptive and did not quantify the extent of mechanical damage or determine the specific operating conditions responsible for the observed risks. Therefore, the findings

identified potential vulnerability points rather than established a causal relationship between washing operations and subsequent quality losses.

Packaging and transportation provided another important connection between postharvest handling and product quality. The flexible mesh bags may have facilitated handling and distribution, but their protective capacity against compression and impact may have been more limited than that of packaging systems designed to provide greater structural protection. This was relevant because postharvest losses may result from cumulative physical stress across several stages rather than from a single operation (Kitinoja & Kader, 2015). Research on carrot handling and packaging has also demonstrated that packaging conditions can influence the maintenance of microbial safety and product quality during storage (Amin et al., 2021). The present findings therefore suggested that packaging and transportation should be considered together when assessing physical quality vulnerability within the local supply chain.

No dedicated cold storage was observed at the study location, where carrots were generally distributed shortly after handling. Previous research has demonstrated that storage temperature strategies can affect carrot weight loss, respiration rate, and disease development (Heltoft et al., 2026). From a supply-chain perspective, this indicated that storage conditions were connected to the continuity of quality after handling and distribution. However, because the present survey did not directly measure weight loss, respiration, or disease development, the findings only indicated a potential storage-related vulnerability and should not be interpreted as direct measurements of these physiological responses.

Overall, the upstream findings indicated that physical quality vulnerability may have occurred across several interconnected handling stages rather than at a single point. Washing, packaging, and transportation may have exposed carrots to different forms of physical stress, while storage conditions may have influenced the subsequent maintenance of quality. This supported a supply-chain perspective in which postharvest quality is considered as a continuous process extending from harvesting and handling to distribution, rather than as an outcome determined by one individual operation.

Consumer Quality Perceptions

The consumer responses indicated that visible physical attributes were relevant considerations in the evaluation of carrot quality. Most respondents preferred very clean carrots, while half reported that they would reject carrots with visible physical defects. These findings suggested that observable characteristics may have influenced consumers' initial evaluation of fresh carrots, particularly because cleanliness and visible defects can be assessed directly at the point of purchase. This was consistent with the principle that fresh-produce quality is commonly evaluated through sensory and visual attributes that can be assessed before consumption (Kader, 2002).

The preference for cleaner carrots was consistent with previous research showing that consumers consider product appearance and other observable characteristics when evaluating fresh vegetables. Prisant et al. (2024) reported that consumer preferences for carrots were associated with product characteristics, while Yang et al. (2021) demonstrated that consumers' preferences for fruits and vegetables can vary according to perceived food values and product attributes. Studies of Indonesian consumers have also shown that quality-related characteristics can be relevant to preferences and willingness to pay for vegetables (Hasanah & Yanuar, 2024; Noor et al., 2024). In the present study, cleanliness was examined as a consumer-perceived physical attribute, providing a localized description of how consumers in the study area evaluated carrot quality.

The responses to physical defects provided further evidence that visible quality was relevant to consumer purchasing decisions. Half of the respondents stated that they would reject carrots with visible defects, whereas 40.0% would consider purchasing them at a discounted price. This pattern showed that consumers did not respond uniformly to physical defects. Some respondents treated visible damage as a reason for rejection, whereas others considered price when deciding whether to purchase affected carrots. Such variation was consistent with research showing that consumers may assign different values to product attributes when evaluating fresh vegetables (Kendiza et al., 2025; Yang et al., 2021).

The findings could therefore be interpreted from a consumer-valuation perspective: physical quality observed at the point of purchase may become part of the information consumers use when forming purchasing responses. This provided a downstream complement to the upstream observations of potential physical damage in the supply chain. However, the present study did not measure the relative importance of cleanliness, freshness, appearance, or physical defects using a preference model, nor did it statistically test their effects on purchasing decisions. Therefore, the observed response patterns could not be interpreted as evidence that a particular quality attribute independently determined consumer behavior. They instead indicated that visible physical quality was a relevant consideration among the consumers surveyed in Blumbang Village.

Household Storage Practices and Deterioration

The household storage practices reported by consumers showed that carrots were stored under different conditions, with half of the respondents using a refrigerator with a closed container, while others stored carrots at room temperature or in a refrigerator without a closed container. These differences indicated that household storage practices were not uniform among the surveyed consumers. Such variation was relevant because storage conditions form part of the post-purchase environment in which fresh-produce quality continues to change. Kader (2002) emphasized that appropriate temperature and handling conditions are important for slowing postharvest deterioration and maintaining the quality of fresh produce.

Softening or wilting was the most frequently reported form of deterioration during household storage, followed by slimy decay. These observations were consistent with the general postharvest principle that fresh produce continues to undergo physiological and microbiological changes after harvest. Water loss can contribute to wilting and loss of firmness, while unfavorable storage conditions may increase the risk of decay. However, the present study recorded these conditions based on consumer reports and did not directly measure moisture loss, firmness, microbial populations, or storage temperature. Therefore, the reported deterioration should be interpreted as household-level quality changes reported by consumers rather than quantified physiological or microbiological responses.

The reported storage practices could also be considered in relation to temperature management. Heltoft et al. (2026) demonstrated that storage temperature strategies affect weight loss, respiration rate, and disease development in carrots, indicating that temperature management is an important component of carrot storage. The present findings complemented this evidence from a consumer perspective by showing that household storage conditions varied and that deterioration was commonly reported during storage. Nevertheless, because the survey did not experimentally compare storage treatments, it could not establish that one household storage practice caused a particular form or rate of deterioration.

From a supply-chain perspective, these findings extended the analysis beyond the farmer and collector levels. Quality management does not end when carrots reach consumers because handling and storage continue after purchase. The reported variation in storage practices and the occurrence of softening, wilting, and slimy decay indicated that the continuity of carrot quality involved both pre-market and post-purchase stages. Thus, consumer-side storage could be considered a downstream component of the same quality pathway identified in the upstream supply chain.

Stated Willingness to Pay for Improved Physical Quality

The stated willingness-to-pay responses indicated that improved physical quality had potential economic relevance among the surveyed consumers. Sixty percent of respondents stated that they were willing to pay an additional IDR 500–1,000 per kg for carrots with better physical quality, while 20.0% were unwilling to pay an additional premium and another 20.0% indicated that their willingness to pay depended on the physical condition of the carrots. This distribution showed that consumers did not have a uniform response to additional payment for improved quality.

The finding was consistent with previous studies showing that consumers may express additional willingness to pay for fresh vegetables with attributes perceived as desirable. Kendiza et al. (2025) reported willingness-to-pay responses among consumers of fresh vegetables, while Noor et al. (2024) found that quality-related attributes were relevant to Indonesian consumers' preferences and willingness to pay for certified vegetables. Research on organic vegetables has likewise demonstrated variation in consumers' willingness to

pay according to perceived product attributes and consumer characteristics (Hasanah & Yanuar, 2024; Banjarnahor & Setiadi, 2024). These studies provided a broader context for interpreting the present finding, although their product attributes and market settings differed from the local carrot context of Blumbang Village.

The present study added a localized perspective by relating stated WTP specifically to improved physical quality of carrots within the same consumer group that reported preferences for cleanliness and responses to visible defects. The fact that 60.0% of respondents stated a willingness to pay an additional IDR 500–1,000 per kg indicated that improved physical quality had perceived economic value for part of the surveyed consumer group. This finding was particularly relevant when considered alongside the upstream observations, because physical quality vulnerabilities identified during handling may have affected attributes that consumers subsequently evaluated at the point of purchase.

However, the stated WTP should not be interpreted as an estimate of an actual market price premium or realized purchasing behavior. Stated WTP reflected respondents' reported intentions under the survey conditions and may differ from actual payment behavior in the marketplace. The 20.0% of respondents who were unwilling to pay an additional premium and the 20.0% whose responses depended on physical condition further demonstrated variation in consumer valuation. This variation was consistent with the broader understanding that consumer preferences for fresh produce can differ according to perceived product attributes and individual food values (Yang et al., 2021).

Taken together, the findings connected the upstream and downstream dimensions examined in this study. Potential physical quality vulnerabilities during washing, packaging, transportation, and storage were relevant not only to postharvest management but also to the quality characteristics encountered by consumers. At the same time, consumer responses indicated that physical quality could have perceived economic relevance for part of the surveyed group. The study therefore provided a descriptive supply-chain perspective linking postharvest handling conditions with consumer-perceived quality and stated WTP within the same local context. Further research using larger samples, quantitative quality-loss measurements, and inferential or econometric methods would be needed to examine the strength of these relationships and determine whether specific quality attributes are associated with actual willingness-to-pay behavior.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study demonstrates that postharvest handling and consumer quality valuation can be examined as complementary components within the local carrot supply chain in Blumbang Village, Tawangmangu. By considering farmers, collectors, and final consumers, the study provides

an integrated description of potential quality vulnerability points during upstream handling and consumer responses to carrot quality at the downstream level.

The findings indicate that mechanical washing, packaging, transportation, and storage represent potential points of physical and physiological quality vulnerability in the local carrot supply chain. These findings are consistent with previous research emphasizing the importance of postharvest handling, packaging, and storage conditions in maintaining the quality of fresh horticultural commodities (Kader, 2002; Kitinoja & Kader, 2015; Djarkasi et al., 2026; Heltoft et al., 2026). The absence of dedicated cold storage further indicates a potential limitation in local postharvest infrastructure. However, because the present study did not quantitatively measure physical damage, weight loss, respiration, or disease development, these findings identify potential vulnerability points rather than establish their direct effects on quality loss.

From the consumer perspective, cleanliness and visible physical condition were relevant considerations among the surveyed respondents. A total of 60.0% of consumers preferred very clean carrots, while 50.0% stated that they would reject carrots with visible physical defects. These findings are consistent with previous research indicating that observable product characteristics can contribute to consumer preferences for fresh vegetables (Prisanti et al., 2024; Yang et al., 2021; Noor et al., 2024). In addition, 60.0% of respondents stated that they were willing to pay an additional IDR 500–1,000 per kg for carrots with better physical quality. This finding is consistent with previous studies showing that consumers may express additional willingness to pay for quality-related attributes of fresh vegetables (Kendiza et al., 2025; Hasanah & Yanuar, 2024). Nevertheless, consumer valuation was not uniform, as 20.0% were unwilling to pay an additional premium and 20.0% indicated that their WTP depended on physical condition.

The main contribution of this study is the integration of upstream postharvest observations and downstream consumer responses within the same local carrot supply-chain context. Theoretically, the findings support a supply-chain perspective in which postharvest handling conditions and consumer-valued physical quality are connected components of fresh-produce quality management. Practically, the findings provide context-specific evidence for identifying handling stages that may require greater attention and physical quality attributes that are relevant to surveyed consumers. Because the study employed purposive sampling and a small descriptive sample, the findings apply to the study context and should not be generalized directly to other carrot-producing areas.

Recommendations

Based on the identified potential vulnerability points, farmers and collectors may consider developing simple shared procedures for harvesting, mechanical washing, packaging, and transportation. Attention should be given to minimizing unnecessary physical stress during washing and handling and to improving the protective function of packaging. Farmer

groups and relevant agricultural institutions may support the evaluation and adoption of locally feasible postharvest technologies, including more protective packaging and appropriate temporary storage facilities. Such improvements should consider the technical and economic capacity of local supply-chain actors so that recommended practices remain feasible under local conditions.

Future research should move beyond descriptive assessment by quantitatively measuring postharvest losses and experimentally evaluating washing conditions, packaging materials, and storage temperatures. Consumer studies could also involve larger samples and inferential or econometric approaches to examine the relationship between specific quality attributes and willingness to pay. Further economic analysis would help assess whether the stated additional WTP is sufficient to offset the costs associated with postharvest improvements.

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