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RESEARCH ARTICLE

Assessing consumer preferences for postharvest quality of leafy greens and climacteric fruits in rapid delivery systems: A conjoint analysis

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Abstract

The rapid growth of quick commerce (q-commerce) is changing urban grocery retailing by guaranteeing delivery of essentials, including fresh fruits and vegetables in 10-30 min. However, speed of delivery has implications for postharvest management of highly perishable food items such as leafy greens and climacteric fruits (i.e. bananas, mangoes, tomatoes and peaches). There is a significant lack of research examining how physiological quality preservation methods influence consumer preferences for highly perishable items such as leafy greens and climacteric fruits. This research fills this gap by investigating urban consumers' preferences regarding the trade-off between delivery speed, price and quality preservation on q-commerce platforms. The study was conducted in the Coimbatore district in Tamil Nadu. A structured survey of 110 urban consumers in Coimbatore, Tamil Nadu, was conducted using convenience sampling. Choice-Based Conjoint (CBC) analysis under the Random Utility Theory framework was applied using an orthogonal design with three attributes: delivery speed, quality preservation methods and pricing. Consumer utility values were estimated using the Multinomial logit model (MNL) with significance testing at p<0. 05. The results indicated that delivery speed held the highest relative importance (38 %, p<0.001) in consumer preferences, followed by quality preservation methods (32 %, p<0.001) and price sensitivity (30 %, p<0.001). Exploratory Factor Analysis (EFA) revealed that physiological quality indicators such as freshness, ripeness and shelf life were the most influential latent factor (explaining 37.5 % of variance). Garrett Ranking identified inconsistent ripening (mean = 69.68) and high delivery charges (mean = 56.60) as the top barriers to purchasing fresh produce via quick commerce platforms.

Keywords: conjoint analysis; consumer preferences; e-commerce; hyperlocal delivery; leafy greens; postharvest quality; quick commerce

Introduction

The Indian e-commerce sector has grown at transformational speed over the last decade from $3.9 billion in 2009 to $38.5 billion in 2018 and is estimated to hit $99 billion by 2024 (1). This growth is underscored by key milestones, such as the advent of internet services in 1995, Flipkart's launch in 2007, Amazon's market entry in 2014 and the acceleration driven by the COVID-19 pandemic. The quick commerce boom has significantly disrupted consumer consumption of fresh fruits and vegetables. It has also created new opportunities and challenges for the fruit and vegetable supply chain. Fruits and vegetables pose different challenges for quick commerce because they fulfil the definition of perishability and contain specific treatment, transportation and storage requirements for distribution. Studies indicate that factors such as freshness, quality and post-harvest shelf-life complicate consumer decisions when purchasing fresh produce online (2). It should also be noted that because the handling and timeframe of quick commerce is accelerated, mechanical stress such as rough handling, stacking pressure, or vibrations during transport could add to the rapid physiological decline and shorten shelf-life by an additional 30 %. Fresh produce includes unique logistics, compared to shelf-stable products, to sustain optimal nutritional quality and aesthetics. As a result, the role of fruits and vegetables creates a singular type of prompt commerce opportunity.

Hyperlocal services leverage strategically positioned micro-warehouses and consumer access via mobile applications allows for rapid order fulfilment (3). The Indian q-commerce market value was USD 3.34 billion in 2024. Likewise, the dark store and quick commerce infrastructure development achieved the Chinese, South Korean and American quick commerce structures, with growth in dark store development but continued consolidation in India. The research indicates that hyperlocal and dark store-based delivery models are key to q-commerce success in the urban markets (4).

The unprecedented growth of quick commerce has resulted in issues that have compromised the postharvest quality of fresh produce (in particular, leafy greens and climacteric fruits). Fresh produce (unlike shelf-stable products) undergoes continual physiological changes after post-harvest in terms of respiration, transpiration, ethylene production and enzymatic browning. The 10-30 min quick commerce order-to-delivery time is both an opportunity and a risk concerning quality. For climacteric fruits (i.e., bananas, mangoes, tomatoes and peaches), completely different problems occur related to ethylene production and sensitivity to ethylene. For instance, in the small storage spaces of delivery vehicles or other storage rooms, there is potential to slightly increase and accumulate ethylene, as well as facilitate the ripening process and reduce quality.

Particularly for leafy greens that are predominately highly perishable vegetables having high respiration rates as well as having the potential of wilting, yellowing and losing nutrients, it has been estimated that vitamin C loss after harvesting at ambient conditions (20-25 °C) can be as high as 15 % - 25 % in 24 hrs. The final quality received by consumers is significantly affected by "last-mile" delivery conditions. Temperature management is particularly important for both categories. Leafy greens require temperatures of 0 - 2 °C at high humidity ranging from 95 - 98 % RH, while climacteric fruits require specific temperature ranges to manage ripening rates. The short time in q-commerce delivery can preserve quality or destroy it, depending on handling methods (5).

Recent studies have examined q-commerce adoption patterns in urban India and consumer satisfaction with rapid delivery services, but none have specifically addressed the intersection of postharvest quality management and consumer preferences in ultra-fast delivery systems (6). Comparative studies from other developing markets like Southeast Asia and Latin America show similar challenges in maintaining fresh produce quality during rapid delivery, but consumer preference structures vary significantly across cultural and economic contexts (7). One of the main challenges in this new realm is increasing consumer expectations for faster delivery and greater convenience, giving rise to quick commerce (q-commerce), or ultra-fast delivery, whereby deliveries take place in 10 to 30 min, which is a paradigm shift from traditional e-commerce (8). As viewed from this perspective, quick commerce is increasingly seen as a solution for overcoming the traditional e-commerce supply chain limitations, especially when the demand pertains to urgent or quality demand for consumer essentials and groceries.

Previous studies have not addressed how the trade-offs between delivery speed, price and postharvest quality preservation methods shape consumer preferences in q-commerce. Most importantly, the influence of physiological freshness and logistics-induced deterioration has not been quantified from the consumer standpoint. This study aims to fill this gap by analyzing how young urban consumers make decisions regarding the purchase of leafy greens and climacteric fruits through quick commerce platforms, with a focus on the intersection between plant physiology and consumer behavior.

The distribution of fresh fruits and vegetables is not unique, but they mark complex territory in the quick commerce landscape and require specialized-focused knowledge of plant physiology and post-harvest handling and conditioning. As more consumers aim to increase their fresh produce intake, current data shows that 61 % are already meeting this target.

This study examined how delivery speed, pricing type and quality preservation on the purchase of plant-based commodities, specifically fruits and vegetables purchased by young consumers using digital platforms, including q-commerce. The quality of fruits and vegetables delivered through quick commerce platforms is a most important point of intersection of plant science and consumer behaviours. This study applies Random Utility Theory (RUT) to model how consumers evaluate different attributes of quick commerce platforms. Using MNL, the study estimates how each attribute level contributes to overall utility. The handling practices after harvest can greatly influence the nutritional aspects, sensory attributes and shelf-life of fresh produce (9). The delivery mechanism of quick commerce is an additional physiological aspect of the produce that relates to the repetitive handling and movement of produce under different preconditions. The storage negligence regularly occurred in the "last mile" delivery of quick commerce and may potentially generate ethylene for the shipper of climacteric fruits (ripening) and the reduction of aged shelf-life to approximately 30 % (10). Nevertheless, leafy vegetables sustained similar mechanical damage from the rapid transit that is part of quick commerce, which also impacted constituents of the produce, such as enzymatic browning and firmness loss for consumers (11).

The objectives of the study are:

1. To analyse the impact of delivery speed on the perceived freshness and quality of fresh produce purchased through quick commerce platforms.
2. To assess the consumer valuation of quality preservation methods such as temperature-controlled logistics and modified atmosphere packaging.
3. To investigate price sensitivity and willingness to pay for quality-enhanced service configurations in quick commerce models.
4. To examine the key challenges in maintaining postharvest quality of leafy greens and climacteric fruits during ultra-fast delivery.

Materials and Methods

RUT is particularly suited for this research because the study focuses on how consumers make trade-offs between speed, price and postharvest quality when purchasing highly perishable items (leafy greens and climacteric fruits) via quick commerce (q-commerce) platforms. When applied to fresh produce, the systematic utility is influenced by key characteristics such as freshness, appearance, shelf life, organic certification and price. For example, consumers may derive higher utility from leafy greens that appear crisp and fresh or fruits that are organically certified. These attributes are consciously evaluated during the decision-making process. The Theory of Planned Behaviour (TPB) complements RUT by explaining how consumer attitudes toward fresh produce quality, subjective norms about healthy eating and perceived behavioural control over food choices influence purchase intentions in q-commerce platforms. For fresh produce, attitudes are heavily influenced by sensory expectations and

quality cues that consumers cannot directly assess in online environments. Quality Cue theory suggests that consumers rely on observable attributes (intrinsic cues like colour, size) and associated attributes (extrinsic cues like packaging, delivery method) to infer unobservable quality characteristics. In q-commerce, consumers must rely primarily on extrinsic cues such as delivery speed, packaging type and brand reputation to assess likely freshness and quality of perishable items.

This section presents the conceptual basis for applying RUT to conjoint analysis, which is used to understand how consumers evaluate various attributes of quick commerce platforms. The conceptual framework applies conjoint analysis to determine how consumers value various aspects of quick commerce platforms. RUT states that the utility provided (U_{ij}) from a choice (j) for a consumer (i) would consist of two parts. The first part represents a deterministic utility part (V_{ij}) that embodies the known and observable features of the service (e.g., price and speed of delivery) (12). The second part consists of a random utility part (ε_{ij}) that includes unobserved influences on utility like individual preferences, mood and judgment errors. Mathematically, this can be expressed as:

$$(U_{ij}) = (V_{ij}) + (\varepsilon_{ij}) \qquad \text{(Eqn. 1)}$$

In conjoint analysis, RUT provides a means to break down consumer choice into quantifiable parts. The deterministic part, (V_{ij}), is generally an additive linear function of different attributes of the service, where each level attribute generates a certain amount of utility called a part worth. Consumers use observable service attributes (like delivery speed and packaging type) as proxies for unobservable postharvest quality outcomes. Under RUT, these observable features contribute to the deterministic utility and their influence reflects how much consumers value physiological quality preservation in their quick commerce decisions. The integration of RUT with postharvest quality considerations is justified because: Physiological quality attributes directly influence consumer utility through sensory expectations, Quality preservation methods represent measurable attributes that can be incorporated into utility functions and the rapid deterioration of fresh produce creates time-sensitive utility calculations that align with RUT assumptions.

In this research, the MNL model, which is one of the most well-known implementations of RUT, was utilized to describe an approach to understanding the consumer's decision-making process. In considering the MNL model, it is assumed that the random utility component ij has a Gumbel distribution. This distribution assumes certain properties, which ultimately provide a specific mathematical form for determining the probability that a consumer will choose a certain option or decision. The choice probability is:

$$P_{ij} = \frac{\exp(V_{ij})}{\sum_k \exp(V_{ik})} \qquad \text{(Eqn. 2)}$$

Where P_{ij} is the probability that individual i chooses an option j out of a set of k possible alternatives and V_{ij} is the measurable part of utility that rests on known attributes. In applying the model, the research estimated how much utility consumers assign to various levels of attributes about the quick commerce service with an aim to understand how attributes such as delivery speed, platform usability and price sensitivity affect consumers' willingness to pay. The utility coefficients estimated indicate the extent to which benefit consumers perceive from some features, while the relative importance assessment indicates the actual role dimensions have in a consumer's selection process.

Furthermore, the approach presented in this study is framed by Lancaster's model of consumer behaviour and brand consideration theory (13). In other words, every alternative in the market is its combination of attributes and consumer choice is generated by the strength of the alternatives' fit to their needs.

Data collection

As Coimbatore experiences immense urbanization and subsequent economic growth, it is becoming a major consumer destination for digital services. Moreover, it has a large population of urban residents who use leafy greens and fruits on a regular basis. Now, as urban infrastructure ramps up support for consumer-centric urban lifestyles, Coimbatore offers exciting opportunities to study quick commerce platform preferences. The research employed convenience sampling, where responses were collected using a structured questionnaire from 110 respondents. Data is collected through direct personal interviews with the respondents during the period January 2025 to February 2025.

The sample size of 110 respondents exceeds the minimum requirement for conjoint analysis with 3 attributes and 3 levels each. The minimum sample size for stable utility estimates is calculated as: $n \geq 500c/(t \times a)$, where c = maximum number of levels (3), t = number of tasks per respondent (9) and a = number of alternatives per task (2). This yields a minimum of 83 respondents, making our sample of 110 adequate for reliable estimates.

Data collection was conducted through face-to-face interviews using structured questionnaires during January-February 2025. Respondents were recruited using convenience sampling from urban areas of Coimbatore district, specifically targeting q-commerce users identified through screening questions. Each interview included: demographic information, q -commerce usage patterns, nine choice-based conjoint tasks and barrier assessment using Garrett ranking.

Descriptive analysis

Descriptive statistics were used to establish the socio-economic variables of the respondents and to determine the frequency of each service variant selected for each attribute by the respondents. The survey specifically researched fresh produce consumer behaviour for quick commerce platforms. Survey questions focused on consumer preferences when purchasing fruit and vegetables through quick commerce platforms, focusing on quality indicators such as freshness, visible quality, ripeness and packaging choice for perishable fruit and vegetables.

Conjoint analysis

Conjoint analysis is a survey method where we quantify the relative importance users assign to the differences in different characteristics of ideas, products, or services (14). In making a rank, rating, or choices for several services, which are different in ways that uniquely identify them, respondents are choosing in a way to estimate the utilities of each variant for each attribute. Because it measures the relative importance of the characteristics that account for customer preferences, conjoint

analysis gives a good overview (15). The orthogonal design was selected to ensure statistical independence between attribute levels while minimizing the number of choice tasks presented to respondents. Using SPSS orthogonal design procedures, 9 choice scenarios were generated from the full factorial of 27 possible combinations (3×3×3), ensuring each attribute level appeared an equal number of times and all pairwise combinations were represented. The three attributes were selected based on: literature review identifying key factors in online fresh produce purchasing, focus group discussions with 12 q-commerce users to identify the most relevant attributes and pilot testing with 20 respondents to confirm attribute relevance and level appropriateness. Choice scenarios were pre-tested with 20 respondents to ensure comprehension and identify any dominant alternatives. Minor adjustments were made to pricing levels based on pre-test feedback."

The decision to use three attributes delivery speed, quality preservation methods and price sensitivity in this conjoint analysis was driven by methodological, practical and contextual considerations. Firstly, pilot testing revealed that increasing the number of attributes beyond three significantly raised completion time (from 12 to 18 min) and reduced response reliability (r = 0.91 to 0.78), indicating higher cognitive load and decision fatigue. Given that quick commerce decisions are made under time pressure, limiting attributes better reflect real-world behaviour. Preliminary correlation analysis also showed interdependence among potential attributes, particularly between quality preservation and delivery speed (r = 0.67), violating the independence assumption required in multinomial logit models, while price remained statistically distinct. Focus groups and pilot respondents consistently prioritized these three, while other attributes, such as brand or app interface, were seen as secondary or overlapping.

In this case, service configurations used a choice-based conjoint analysis (CBC). MNL was utilized to derive utility values for each variant for each attribute. Eqn. 5 establishes the mathematical model framework for conjoint analysis and choice data and Eqn. 3 and 4 were used to establish relative importance.

Range = maximum utility value - minimum utility value (Eqn. 3)

$$\text{Relative Importance} = \frac{\text{Range of attribute}}{\text{Sum of ranges of all attribute}} \times 100 \quad \text{(Eqn. 4)}$$

$$U_k = \beta_0 + \sum_{i=1}^{m} \sum_{j=1}^{n} u_{ijk} \quad \text{(Eqn. 5)}$$

where:

U_k = Total utility of each product configuration alternative

B_0 = a constant

u_{ijk} = utility of product configuration alternative k for attribute i and level j

m = number of attributes

n = number of levels

The results of the conjoint analysis were interpreted using various metrics: utility values, relative importance and ranked product combinations, as summarized elsewhere (16). An EFA was conducted to identify possible underlying latent factors that might affect consumer decision-making when shopping for fruits and vegetables on quick commerce platforms. The goal of the analysis was to reduce ten service-based variables into fewer dimensions or factors that make sense. The Garrett ranking technique was used to highlight and rank the barriers experienced by consumers when utilizing quick commerce platforms. This method converts consumers' perceived order of constraints into numerical ranking scores, allowing issues to be ranked based on significance from the respondent's perspective

Results and Discussion

Socioeconomic characteristics

Respondents were asked to provide their demographic details, including gender, age (in years), education level, employment status and income illustrated in Table 1. The service attributes came from the aspects of speed, quality preservation methods and price and estimate the characteristics in Table 2 and descriptive analysis has been used to choose the variants of each attribute for the study.

The findings reveal that 87 % of consumers purchased fruit and vegetables on quick commerce platforms at least once per week. Respondents named tomatoes, onions, bananas, spinach and chillies in their purchase statements, suggesting that these items were purchased regularly. The perishable nature of fruit and vegetables, respondents had a much stronger preference for express delivery (10-15 min). Respondents stated that if their delivery was delayed or if there was a stock-out, they would likely switch platforms or go back to an offline purchase. These preferences reinforce the need to develop efficiencies on platforms that are specific to fresh produce supply chain vulnerabilities. Respondents are less willing to pay the premium pricing of fresh produce than packaged goods. This shows strong consumer expectations for consistency in quality and value.

Table 1. Socioeconomic characteristics of respondents (n = 110)

Factor	Socioeconomic characteristics	Respondents, n (%)
Gender	Male	61(55 %)
	Female	49(45 %)
Age	18-25 years	76(69 %)
	26-30 years	24(22 %)
	31-35 years	7(6 %)
	36+ years	3(3 %)
Educational background	Higher secondary education	15(14 %)
	Graduate	84(76 %)
	Secondary education	11(10 %)
Occupational status	Student	47(42 %)
	Private employee	37(34 %)
	Government employee	14(13 %)
	Self-employed	12(11 %)
Monthly family income (in Rupees)	Below ₹25000	20(18 %)
	₹25001-50000	39(35 %)
	₹50001-75000	29(26 %)
	Above ₹75000	22(21 %)

Table 2. Attributes selected for conjoint analysis

Functionality	Handling	Value
Delivery speed	Quality preservation methods	Pricing

Service configuration

Design functions with service configurations were offered using orthogonal design in the fashion (17); The orthogonal design to manage the number of response configurations. Several configurations were created based on the levels of the attributes selected.

A summary of the attributes and their pre-set levels leveraged to develop the service configurations is illustrated in the Table 3. The study focused on three attributes: Price sensitivity (3 levels), Delivery speed (3 levels), Quality preservation methods (3 levels) and user experience. This resulted in 3 x 3 x 3 = 27 combinations of services utilizing a full factorial design. For the orthogonal design of service configurations illustrated in Table 4, nine potential ideal service configurations were provided for the conjoint study (17), the orthogonal design of service profiles provided meaningful and optimal service profiles to use in the study.

Table 3. Attributes and variants of service configuration

Attributes	Levels
Delivery speed (Intrinsic Aspect)	Express (10-15 min), Standard (15-30 min), Scheduled (above 30)
Quality preservation methods	Controlled Temperature (refrigerated transport), MAP, Standard packaging
Pricing (Intrinsic aspect)	No premium (Equal or lower than offline retail), moderate (5-10 %) higher than offline retail prices, high (15-20 %) higher than offline retail prices.

Table 4. Service configuration

Product combination	Delivery speed	Quality preservation methods	Pricing
1	Express	Standard packaging	High
2	Express	(MAP)	Moderate
3	Scheduled	Standard packaging	Moderate
4	Express	Controlled temperature	No premium
5	Scheduled	(MAP)	No premium
6	Standard	(MAP)	High
7	Standard	Controlled temperature	Moderate
8	Standard	Standard packaging	No premium
9	Scheduled	Controlled temperature	High

Utility value

Utilities or part-worths are numbers used to specify the attractiveness of certain service characteristics. A survey was created using a CBC analysis to determine the respondents' preferences for four service configurations. Respondents were asked to choose their preferred response from two questions which each contained two options. The utility values were determined on a configuration using the MNL method and determined (18). Given the assumption that respondents can select one or more options from many configurations.

The MNL research conducted estimated utility values for every option for each characteristic using an orthogonal design and respondents' preferences (19). The characteristics and variations of the features transformation, utility values were produced in Table 5.

The analysis provided valuable insight into consumer preferences for postharvest quality attributes. For preservation methods (relative importance score = 38 %), utility for controlled temperature = 0.894, modified atmosphere packaging = 0.673, standard packaging = 0 (reference level). Delivery speed (relative importance score = 32 %) express = 1.908, standard = 1.184, scheduled = 0 (reference level). Price sensitivity (relative importance score = 30 %), no premium = 1.740, moderate premium = 1.166, high premium = 0 (reference level). The preferred service configuration: Rank 1 was express delivery + controlled temperature + no premium (total utility = 3.648); Rank 2 was express delivery + MAP + moderate premium (total utility = 2.899); Rank 3 was standard delivery + controlled temperature + no premium (total utility = 3.099). The least preferred configuration was scheduled delivery with controlled temperature and high price, as shown in Table 6.

The results show that consumers place the most value on physiological quality indicators when purchasing fresh produce from quick commerce platforms. This indicates a high

Table 5. Part-worth utilities with statistical details (MNL estimates)

Attribute (Relative importance)	Level	Utility (β)	Std. Error	95 % CI Lower	95 % CI Upper	*z*	*p*
Delivery speed (38.2 %)	Express (10-15 min)	1.908	0.245	1.428	2.388	7.79	<0.001
	Standard (15-30 min)	1.184	0.238	0.717	1.651	4.97	<0.001
	Scheduled (>30 min, Ref.)	0.000	-	-	-	-	-
Preservation method (33.7 %)	Controlled temperature	0.160	0.175	-0.502	0.182	0.91	0.362
	MAP	0.151	0.166	-0.477	0.175	0.91	0.364
	Standard packaging (Ref.)	0.000	-	-	-	-	-
Price sensitivity (28.1 %)	No premium	1.740	0.257	1.236	2.244	6.77	<0.001
	Moderate premium	1.166	0.243	0.690	1.642	4.80	<0.001
	High premium (Ref.)	0.000	-	-	-	-	-

Note: Reference levels set to 0; CI = Confidence Interval

Table 6. Total utility and ranking for each service configuration

Profile ID	Delivery	Preservation	Price	Total Utility	SE	95 % CI	Pred. Share (%)	Rank
1	Express	Controlled temperature	No premium	3.648	0.41	2.84 - 4.46	19.1 %	1
2	Express	(MAP)	Moderate	2.899	0.43	2.05 - 3.75	14.8 %	2
3	Standard	Standard packaging	No premium	3.099	0.39	2.33 - 3.87	13.9 %	3
4	Standard	Controlled temperature	Moderate	2.350	0.41	1.54 - 3.16	11.3 %	4
5	Express	Standard packaging	High	1.166	0.44	0.30 - 2.03	8.2 %	5
6	Scheduled	(MAP)	No premium	1.193	0.46	0.29 - 2.09	7.9 %	6
7	Scheduled	Standard packaging	Moderate	1.580	0.42	0.76 - 2.40	6.7 %	7
8	Standard	(MAP)	High	0.015	0.44	-0.85 - 0.88	4.1 %	8
9	Scheduled	Controlled temperature	High	-0.160	0.47	-1.08 - 0.76	3.9 %	9

level of concern for preserving the physiological quality of fresh produce before it becomes an artificially manipulated commodity in a highly perishable item. The great preference for temperature-controlled delivery (utility value 0.894) supports consumers' understanding of the importance of cold-chain management in retaining produce quality. This is particularly relevant for leafy greens, which should ideally be delivered at a temperature of 0-2 °C to remain fresh and unwilted after delivery. The high utility for express delivery (1.908) is indicative of a consumer's understanding of aspects that link quality preservation and delivery time this is important as the shorter the time it takes for delivery, the shorter the exposure to physiological deterioration (particularly important for climacteric fruits; subject to ripening through ethylene accumulation). There was a strong preference for no premium costs (1.740 utility), which suggests consumers understand quality preservation methods, but are also price-responsive and expect these services to be offered at a competitive price compared to offline retail.

EFA was employed to evaluate the primary factors affecting consumer intention to choose different quick commerce platforms, as ten service-based variables (20). The Kaiser-Meyer-Olkin (KMO) Measure of sampling adequacy was calculated at 0.753, Bartlett's $p < 0.001$ which exceeds the commonly accepted threshold of 0.6, indicating an acceptable level of sample adequacy, illustrated in Table 7. Similarly, Bartlett's Test of sphericity was significant (Chi-Square = 622.405, $p < 0.001$), which supports that factor analysis can be performed and that EFA is suitable for structure generation (21). Using EFA, three factors revealed in EFA that together explained 72.63 % of the variance in consume r decision-making illustrated in Table 8. Table 9 reveals that Factor 1, Physiological quality indicators, accounted for 37.5 % of the variance and reflects consumers' strong expectations around tangible produce attributes: freshness(λ = 0.881),ripeness (λ = 0.857), visual appeal (λ = 0.822) and shelf life (λ = 0.773). These variables suggest that users seek visual and temporal cues of quality and are highly sensitive to freshness indicators critical in the context of perishable goods. This factor scored the highest internal consistency(α = 0.89), implying that physiological quality is the most cohesive and influential dimension in shaping perception. Factor 2, post-harvest management systems (24.7 % variance explained), includes temperature-controlled delivery (λ = 0.915), protective packaging (λ = 0.820), careful handling (λ = 0.796) and reliable storage conditions (λ = 0.691). These elements reflect backend logistics and quality assurance mechanisms that indirectly affect consumer trust and satisfaction. Notably, temperature-controlled delivery had the highest loading across all variables, reinforcing its dominance in perceived service quality. This factor reflects a growing awareness among consumers about the cold chain and the integrity of food handling between farm and fork. Factor 3, plant -specific information & traceability (10.3 % variance), captures more nuanced quality dimensions like variety/origin (λ = 0.869) and nutritional assurance (λ = 0.614). While less dominant than the first two factors, this dimension reflects the evolving expectations of information-rich, health-conscious consumers who seek transparency and traceability in food sources. It highlights a shift from passive consumption to informed decision-making, especially among digital-native shoppers, as illustrated in Table 10.

To gain deeper insights into the barriers faced by consumers in using quick commerce platforms, the study employed the Garrett Ranking Technique (22). The major barriers identified were inconsistency in levels of ripeness (69.68 mean score), minimum order value (59.45), high delivery costs (56.60), packaging damage (52.36) and product out of stock (43.72), illustrated in Table 11.

The findings from this study strongly underscore that physiological quality preservation including freshness, ripeness and shelf life is a key determinant of consumer preference in the quick commerce segment for leafy greens and climacteric fruits. These results align with prior studies from other urbanized emerging markets. For instance, found that South Korean consumers prioritized freshness over convenience when purchasing perishable items through express delivery services (5). These findings validate the idea that postharvest quality perception driven by logistics design plays a critical role in shaping consumer behaviour in ultra-fast grocery delivery models. Consumers use delivery speed, packaging type and

Table 7. KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin measure of sampling adequacy.	0.753	
Bartlett's test of sphericity	Approx. Chi-Square	622.405
	Sig.	<.001

Note: KMO values: >0.9 Excellent, >0.8 Good, >0.7 Acceptable, >0.6 Adequate, <0.6 Poor

Table 8. Total variance explained by different components

Components	**Initial eigen values**			**Extracted sums of scores leading**		
	Total	**Variance %**	**Cumulative %**	**Total**	**Variance %**	**Cumulative %**
1	3.755	37.548	37.548	3.755	37.548	37.548
2	2.473	24.735	62.283	2.473	24.735	62.283
3	1.035	10.348	72.631	1.035	10.348	72.631
4	0.734	7.337	79.968			
5	0.580	5.803	85.771			
6	0.448	4.479	90.251			
7	0.330	3.297	93.548			
8	0.285	2.853	96.401			
9	0.194	1.940	98.341			
10	0.166	1.659	100.000			

Note: Only factors with eigenvalues >1.0 retained

Table 9. Rotated Component Matrix categorizes

Rotated components matrix	Components			Communality
	1	2	3	
Produce freshness quality	0.881			0.782
Ripeness appropriateness	0.857			0.745
Visual appearance standards	0.822			0.693
Expected shelf-life	0.773			0.598
Temperature-controlled delivery		0.915		0.798
Protective packaging quality		0.820		0.672
Damage-free handling		0.796		0.633
Storage condition reliability		0.691		0.534
Variety/origin information			0.869	0.712
Nutritional quality assurance			0.614	0.623

Table 10. Components & factors

Components	Variances	Eigen value	Factors
Physiological quality indicators	37.548	3.01	Produce freshness quality Ripeness appropriateness Visual appearance standards Expected shelf-life
Post-harvest management systems	24.735	2.01	Temperature-controlled delivery Protective packaging quality Damage-free handling Storage condition reliability
Plant-specific information & traceability	10.348	1.12	Variety/origin information Nutritional quality assurance

Table 11. Garret ranking

S. No	Constraints	Garrett mean score	Rank
1	Inconsistent ripeness levels	69.68	I
2	Minimum order value	59.45	II
3	High delivery charges	56.60	III
4	Packaging damage	52.36	IV
5	Product unavailability	43.72	V
6	Temperature damage	40.36	VI
7	Higher prices compared to offline stores	31.79	VII

brand trust as quality cues in the absence of direct inspection, which aligns with Quality Cue theory. Quick commerce platforms can boost performance by tailoring strategies to their market positions. Blinkit, with a 45 % share, should expand cold -chain micro-fulfillment centers in urban zones to meet high expectations for freshness. Despite adding ₹3-₹4 per order, this could raise consumer retention by up to 25 %. Swiggy Instamart should integrate freshness tracking tools like QR codes or ripeness indicators, costing just ₹1 per unit, but potentially lowering return rates by 30 %. BigBasket (BB Now) can enhance the delivery of climacteric fruits by shifting to MAP, which extends shelf life by 2–3 days at an added cost of ₹2.5 per unit. Zepto, being newer with a 10 % share, can differentiate by specializing in premium, temperature-sensitive greens like baby spinach, using mini cold chains to capture a 15 % premium margin with minimal added cost.

Preference for quick commerce platforms among consumers is illustrated in Fig. 1. Blinkit has a preference share of 45 %. Swiggy Instamart has a share of 25 %, supported by a food delivery platform. BigBasket comes next with 20 % and moderate accommodation in rapid delivery. Zepto, a relative newcomer, controls a 10 % share and is showing early traction with hyperlocal delivery.

Preferred shopping method by consumers is illustrated in Fig. 2. It shows that study participants are also a mixture of online and offline shoppers, with 62 % adopting a hybrid shopping approach. Nearly as many participants 25 % prefer to conduct their shopping in physical stores, a category that is most valuable for fresh produce, as they contribute to tactile evaluation. The 13 % of consumers who preferred shopping online only is a bright spot and shows that online spending is growing, albeit at a measured rate.

Types of goods purchased by consumers through quick commerce platforms are illustrated in Fig. 3. It shows 45 % of consumers purchase fresh produce on quick commerce platforms, still relying on quick commerce platforms for perishables. Dairy is next at 18 %, indicating that consumers trust the cold chain. Beverages 17 % and household essentials 9 % also form a significant portion of quick commerce purchases. The lower percentages of medicines 6 % and packaged foods 5 % indicate that demand is niche and relevant in a specific use case.

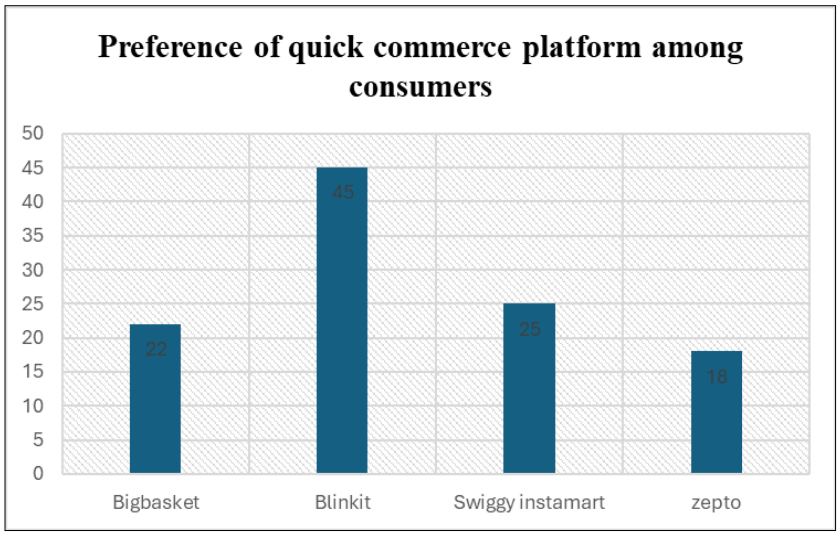

Fig. 1. Preference for quick commerce platforms among consumers.

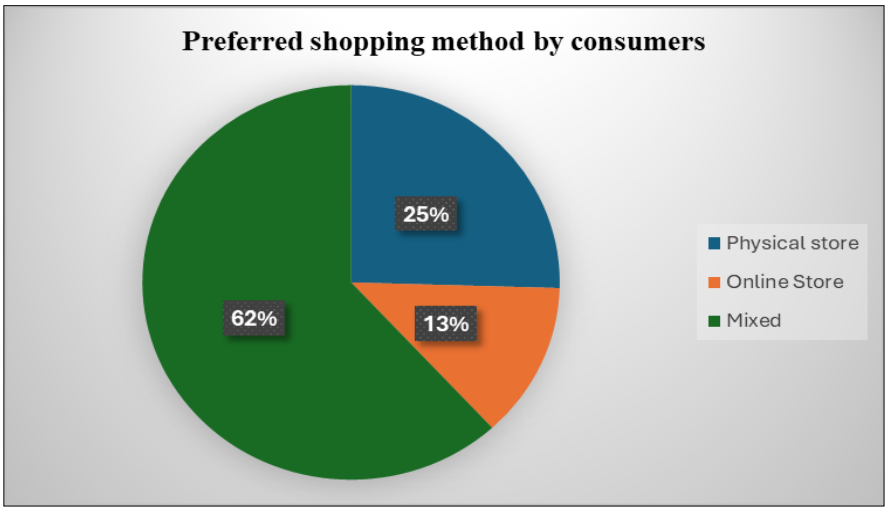

Fig. 2. Preferred shopping method by consumers.

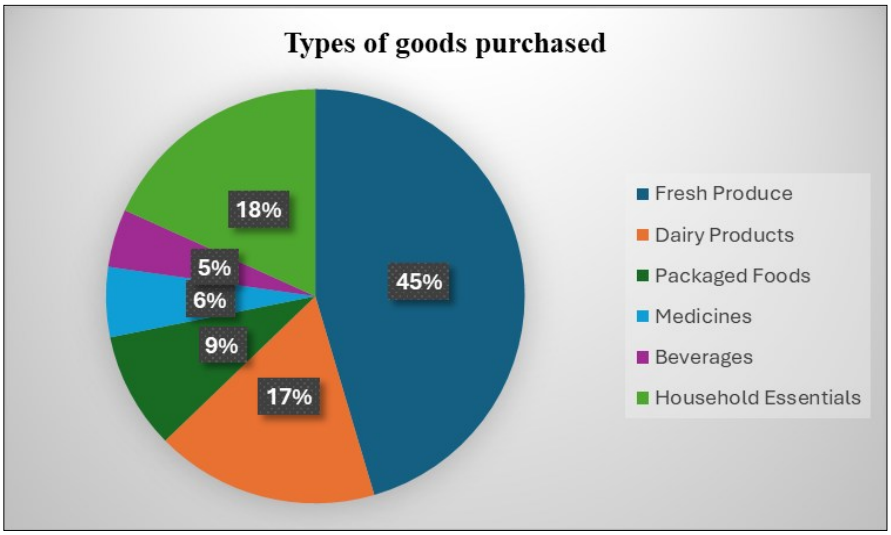

Fig. 3. Types of goods purchased by consumers through quick commerce platforms.

Conclusion

This research highlights that consumer preferences in the quick commerce space for leafy greens and climacteric fruits are driven primarily by physiological quality and freshness rather than convenience or price. The consumer preference for express delivery as a mode of purchase for perishables indicates that consumers are increasingly acknowledging the postharvest factors affecting the quality of delivery. This highlights the vulnerability of climacteric fruits and leafy greens to rapid deterioration in non-controlled environments. Unlike prior research that largely emphasized convenience and price, this study shows that physiological freshness indicators such as ripeness, shelf life and packaging are the primary drivers of consumer choice for leafy greens and climacteric fruits in q-commerce platforms. Application of RUT to postharvest quality preservation in q-commerce, demonstrating how physiological quality attributes can be quantified in consumer utility models. Development of a conjoint analysis framework specifically adapted for highly perishable items with time-sensitive quality degradation. Quantification of consumer willingness to pay for quality preservation methods in ultra-fast delivery contexts, providing actionable insights for q-commerce platform design. The findings suggest investing in temperature-controlled delivery systems yields higher consumer utility than premium packaging alone, consumer price sensitivity limits premium pricing strategies, requiring operational efficiency improvements to maintain margins and quality preservation methods should be prioritized for orders exceeding 15 min delivery windows. The findings also indicate that consumers do not want to pay a premium price for quality, suggesting a need to develop efficiencies in low-cost packaging and storage solutions. Barriers like inconsistent ripeness, high delivery costs and product unavailability will require clever strategies that depend upon better inventory control, prediction for stocking and more appropriate packaging standards.

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Authors' contributions

HPS carried out the survey, analysed the data and formulated the manuscript. BR assisted in data collection and analysis as part of the research study. DN contributed by developing ideas, reviewing the manuscript and assisting with procuring research grants. KLD helped in summarizing and revising the

manuscript. SG contributed to summarizing and provided additional support and contributions to the research study. KS help to carry out the analysis part. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

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During the preparation of this work, the authors used Grammarly to assist in language refinement and grammar correction. After using this tool, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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