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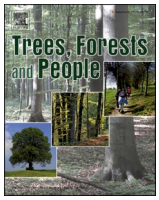

Leveraging urban consumer perceptions to strengthen marketing for baobab, coconut, and tamarind in Mombasa, Kenya

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ABSTRACT

Tree-based forest and agroforestry products (TFAPs) are essential for food security, climate resilience and rural livelihoods in Africa, yet knowledge regarding their consumption in rapidly growing urban centres remains limited. This study investigates the uses, practices, and perceptions of baobab, coconut, and tamarind products among households, restaurants, and traders in Mombasa, Kenya. Using a mixed-methods approach grounded in consumer theory, social practice theory, and the 5P marketing framework, the research identifies distinct roles for each species. Findings reveal that coconut serves as a culinary staple, tamarind as a versatile flavouring and beverage ingredient, and baobab primarily as a snack for children. Principal Component Analysis (PCA) identified four key components shaping consumer evaluations: *Cultural and Environmental Identity, Health and Well-being, Family and Sensory Enjoyment*, and *Preparation Effort and Utility*. While coconut and tamarind are deeply embedded in daily routines due to perceived health benefits and culinary versatility, baobab products consumption remains episodic. The study identifies opportunities to strengthen the value chain through improved quality management in packaging, hygiene, and ready-to-use products, better aligning with urban consumer needs while supporting small-scale branding and promotion.

1. Introduction

Tree-based and agroforestry products (TFAPs) are vital for sustaining rural livelihoods and incomes across Africa. While non-timber forest products (NTFPs) are typically defined as biological products from forests other than timber (CIFOR 2004), this study adopts a broader TFAP concept, encompassing both wild-harvested products—such as tamarind (*Tamarindus indica* L.) and baobab (*Adansonia digitata* L.)—and cultivated tree products like coconut (*Cocos nucifera* L.) (CIFOR 2005).

TFAPs contribute to food security, income generation, household resilience, and cultural value (CIFOR, 2004; Timko et al., 2010; Mwangi et al., 2011; Shackleton et al., 2011; Awono et al., 2016; Shackleton and de Vos, 2022). The importance of TFAPs is rising with Africa's population growth and urbanization, projected to double urban populations by 2050 (Shackleton and de Vos 2022). Expanding urban demand offers both opportunities and challenges for TFAP producers, emphasizing the need for efficient and sustainable value chains and marketing efforts that align with consumers' demand and preferences. This highlights the need for more knowledge about urban TFAP consumption, consumer preferences and consumer behaviour.

Despite long-standing recognition of supply-side constraints in TFAP markets (Timko et al. 2010; Heubach et al. 2011), less is known about urban African consumers, their behaviour and preferences. Amusa et al. (2017) recorded producers' difficulties in meeting market expectations in terms of volume, timing, and quality. Amongst the existing studies on consumers of TFAPs, baobab-focused research in Africa has documented positive consumer attitudes, health motivations, and market opportunities (Agúndez et al., 2018; Saeed et al., 2023; Horlu et al., 2023), Similarly, research in Nigeria and Malawi explored market constraints, household participation, and vital producer income contributions from tree products (Amusa et al., 2017; Mahonya et al., 2019). Soumya et al. (2025) studied the role of the rich cultural aspects and symbolic value of non-wood tree products among customers in South Asia. Comparable African urban analyses are largely absent.

Prior African studies on consumption of fruits and vegetables offer useful parallels to TFAPs. They reveal a willingness to pay for freshness,

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hygiene, appearance, and price (Shafiwu et al., 2018; Alphonce et al., 2025), indirectly suggesting similar conditions for tree-based foods. Overall, there is a gap in understanding urban consumers' social practices, perceptions, and everyday uses of TFAPs, underscoring the need for empirical research focused on urban contexts such as Mombasa in Kenya.

This study aims to document urban consumer behaviours, needs, and preferences to provide empirically grounded insights for low-resource producers and advance understanding of consumer perceptions of agroforestry products (TFAPs). Specifically, the study examines consumer uses, practices, preferences, quality assessments, and perceptions of TFAP in urban contexts. Using Mombasa, Kenya, as a case study, it analyses and generates new knowledge on:

1. Current uses, and practices, of TFAPs among urban consumers
2. Preferences, and quality perceptions among urban users
3. Perceptions among household users toward TFAPs

The findings will inform inclusive, market-oriented strategies that link urban food security with ecological sustainability. By addressing a gap in knowledge regarding urban consumption practices and product uses, the study bridges production-focused TFAP research with the realities of urban markets, offering practical guidance for local producers to enhance their business strategies.

2. Theory

This study draws on three complementary perspectives—consumer theory, social practice theory, and the 5P marketing framework—to analyse urban consumption of tree-based forest and agroforestry products (TFAPs) and to guide actionable marketing strategies. Table 1 summarizes how the perspectives align with the study's research objectives, enabling recommendations that are consumer-informed, socially grounded, and feasible for sustainable marketing of baobab, coconut, and tamarind in Mombasa.

Consumer theory (Lancaster, 1966) explains how urban consumers derive utility from specific product attributes, guiding the identification of quality criteria and desired improvements. The theory posits that consumers develop preferences based on the configuration of attributes embodied in a product. Social practice theory, by contrast, conceptualizes consumption as the performance of practices constituted by materials (products and tools), competences (knowledge and skills), and meanings (cultural and symbolic significance) (Reckwitz, 2002; Neuman, 2019). This perspective can also incorporate family influence (Birch, 1999) and is suited to the analysis of food-related behaviour (Vabø and Hansen, 2014). Social practice theory explains how the products are prepared and used within the consumption, and cultural routines; and the 5P framework translates these insights into feasible marketing and marketing interventions.

Table 1
Association between research objectives and theoretical perspectives.

Objective	Attribute-based preferences (Consumer theory)	Practices, routines & meanings (Social practice theory)	Marketing & value-chain implications (5P)
Current uses and practices of TFAPs among urban consumers	Examines how product attributes facilitate or hinder TFAP uses and practices	Contextualizes and describes use and practices in households' preparation and consumption within household routines	Identifies marketing strategies that use existing practices
Preferences and quality requirements among urban users	Identifies criteria for quality requirements and preferences	Examines how sourcing, preparation, and consumption contexts shape preferences	Identifies key 5P attributes, e.g. product characteristics, influencing preference
Perceptions among household users toward TFAPs	Identifies perceived product attributes of relevance	Highlights cultural and traditional meanings forming perceptions of products	Guides positioning, messaging, and promotion based on perceived product attributes and meanings

The 5P marketing framework translates insights into actionable strategies by linking product attributes, pricing, distribution, promotion, and stakeholder roles to value-chain interventions (Mintzberg, 1987). Although originally developed for industrial, commercial markets, the framework has been applied to agri-food products as an analytical tool for identifying interventions (Rudawska, 2019). Together, the three perspectives form an integrated analytical lens that connects attribute-level preferences, socially embedded practices, and practical marketing solutions to strengthen urban TFAP consumption and marketing.

To operationalize both attribute-based and practice-related aspects of food evaluations, this study draws partly on the single-item Food Choice Questionnaire developed by Onwezen et al. (2019), which captures key motivational drivers underlying food choice. Selected items informed the measurement of health, sensory, and value-related perceptions of TFAPs in the present study.

3. Methods

3.1. Methodological approach

Mixed methods were employed in this study of value streams, uses, practices, processes, perceptions and preferences related to urban flows and uses of TFAPs. Qualitative methods were used to identify practices and patterns of consumption, as well as views on product quality and desired improvements, while quantitative analyses provided understandings of consumers' perceptions and preference. The combination of methods enabled the comprehensive interpretation of urban TFAP consumption, which is required for realistic marketing strategy-making (Ivankova et al., 2006; Hair et al., 2010; Bell et al., 2019).

3.2. Study area

The study was conducted in Mombasa, Kenya, a city of over 1.2 million residents, nearly 41% of whom are under 20 years old, with a poverty rate of 27% (CIDP, 2023). The city is growing at an annual rate of approximately 3.3% (KNBS, 2019). Interviews were carried out across four sub-counties representing diverse socioeconomic contexts. Changamwe (approximately 140 thousand inhabitants) is an industrial hub with a predominantly working-class population and modest residential areas. Kisauni (about 310 thousand inhabitants) is densely populated, featuring informal settlements, active trade, and mainly low- to middle-income residents. Mvita (approximately 164 thousand inhabitants) combines historic old-town areas with pronounced economic inequalities, while Nyali (about 230 thousand inhabitants) is a relatively affluent suburb characterized by modern housing, tourist resorts, and middle- to upper-income households. The population of Mombasa is cosmopolitan and culturally diverse, with strong local communities such as the Arabs, Swahili and Mijikenda, alongside Kenyan and international migrants and traders. As a coastal and port city, its demographic structure is shaped by its role as a gateway, urban centre, and tourist destination.

3.3. Sampling and data collection

To understand the value chain and two main consumer groups, data were collected from traders, restaurants, and households. Respondents were selected to ensure representation of all three target products, tamarind, coconut, and baobab, across different sub-counties. Traders

and restaurant managers were purposively chosen based on their involvement with the products of interest, whereas households were randomly selected to represent low- and middle-income groups. Interviews among traders and restaurants focused on tamarind and coconut whereas households were interviewed about baobab, tamarind and coconut.

A total of 18 traders were interviewed, including six specializing in baobab, six in tamarind, and six in coconut (Table 2). The interviews explored trade characteristics, product flows, and sources to clarify supply chain dynamics. In addition, the study included 68 restaurants serving tamarind, 47 serving coconut, and 32 offering both products, while baobab was less frequently used and therefore not included in the restaurant sample. Participating establishments included 56 small- to medium-sized local restaurants, two hotels, and nine cafés or fast-food outlets. Among the restaurants, 31 owners or managers were female and 37 were male. Surveys collected socioeconomic information, operational details, menu items, processing methods, quantities, quality standards, and desired product improvements.

Household questionnaires gathered information on socioeconomic characteristics, TFAP usage, preparation and consumption practices, quality criteria, and on products perceptions. Data collected included types and quantities consumed, usage trends, prices, perceived attributes, and desired improvements (Questionnaires are available from the authors).

Table 2 summarizes respondents by sub-county, category, and gender. Of the 18 traders, six were female and 12 were male. Among the 68 restaurants, 31 were female-owned or managed and 37 were male; 83 of the household respondents were females and 52 were males Tables also detail the distribution of households and restaurants serving different TFAPs across sub-counties.

All surveys were conducted by trained enumerators with university-level education and proficiency in English and Kiswahili. Training included familiarization with the instruments and survey procedures. Pre-tests in October 2023 refined the tools to improve reliability and remove redundancies. The main survey was conducted in November 2023 across all respondent categories.

The study adhered to established principles of responsible research. Participation was voluntary, and informed consent was obtained from all respondents. Confidentiality and anonymity were maintained, and participants could withdraw at any time. No personal identifiers were recorded, and all data were anonymized prior to analysis. The research did not involve medical interventions, biological samples, or sensitive personal information such as health data, religion, or political opinions. In Sweden, the study did not require formal ethical review under the Ethical Review Act (Görman, 2023), as it involved low-risk social science research. In Kenya, the study followed the national research ethics framework (NACOSTI, 2014). While formal review is generally reserved for biomedical research, the study adhered to principles of respect, beneficence, and justice in collaboration with local researchers and institutions.

The study applied a mixed-methods approach, combining qualitative and quantitative analyses to comprehensively interpret urban TFAP consumption (Bell et al., 2019). Qualitative data on product use, preparation practices, and quality perceptions were examined thematically. Perceptual data were analysed using descriptive statistics and principal component analysis (PCA) to identify key patterns in consumer evaluations. Perception information was collected through a set of Likert-scale items, partly adapted from the single-item Food Choice Questionnaire developed by Onwezen et al. (2019) and partly developed to reflect the Mombasa context (questionnaire available from the author). These items captured health, sensory, cultural, environmental, affordability, and convenience-related evaluations of baobab, coconut, and tamarind. Findings from qualitative and quantitative analyses were integrated to outline supply and marketing conditions, as well as consumer practices, preferences, and perceptions in urban TFAP markets.

3.4. Analysis

The analytical stage combined qualitative and quantitative analytical approaches in line with the research objectives and theoretical framework. Qualitative responses from interviews and open-ended survey questions were analysed thematically. Statements were coded and grouped into categories capturing uses, practices, preferences and perceived attributes related to TFAP use. This process enabled the identification of recurring patterns and meaningful variations across respondent groups.

Quantitative data were analysed using descriptive statistical methods, including frequencies, distributions, and cross-tabulations, to characterise respondents and usage patterns. In addition, multivariate methods were applied to examine perceptions and associations among product attributes and consumer preferences. Statistical analyses were conducted using Microsoft Excel, SPSS (Version 29.0.0.0 [241]) (IBM Corp., 2025)., and XLSTAT (Version 2025.1) (Addinsoft/Lumivero, 2025). Together, these analytical steps allowed for an integrated interpretation of practices, perceptions, and market-related dynamics, ensuring coherence between empirical findings and the study's conceptual and theoretical foundations.

Principal Component Analysis (PCA) was used to reduce the dimensionality of the response data and identify underlying patterns in participant perceptions (principal components). Prior to PCA, the suitability of the data for dimensionality reduction was assessed following standard multivariate guidelines (Hair et al., 2010). Components were retained based on eigenvalues > 1, and factor loadings were examined to interpret the main components. Subsequent analyses were conducted using the retained components. A loading cutoff of 0.5 was applied to ensure practical significance (Hair et al., 2010).

4. Results

4.1. Respondent overview

Respondents were primarily low-income, engaged in informal urban livelihoods, mainly in transport, services, and small-scale retail. The profile information of the respondents is shown in Table 3.

4.2. Supply chains for baobab, coconut, and tamarind

Coconut was the most used TFAP, followed by tamarind and baobab. The majority used more than one product reflecting the wide use of TFAP products. The three TFAPs are sourced through distinct but

Table 2
Respondents by sub-county.

		Traders		Restaurants		Households	
Sub-county	Population	No resp.	Percent	No resp.	Percent	No resp.	Percent
Changamwe	132,882	9	50%	8	12%	25	19%
Kisauni	291,930			22	32%	42	31%
Mvita	151,171	9	50%	19	28%	29	21%
Nyali	216,577			19	28%	39	29%

Source: KNBS (2019).

Table 3
Profile of respondents (HOUSEHOLD data).

Variable	Category	Number
Gender	Female	83 (61.5%)
	Male	52 (38.5%)
Age	Female	39.6 (std dev 10.5)
	Male	40.4 (std dev 10.2)
Education	None	9 (6.7%)
	Primary (Grades 1–6)	35 (25.9%)
	Secondary (Grades 7–12)	46 (34.1%)
	Tertiary (Post secondary)	45 (33.3%)
Income sources	Business	102 (76%)
	House help	6 (4%)
	Housewife	6 (4%)
	Pension	5 (4%)
	Remittances	2 (1%)
	Salary	13 (10%)
	Student	3 (2%)
	Unemployed	1 (1%)
Household Income/month, KES	0–20,000 KES €0–132.8	78
	20,000–40,000 KES €132.8–265.5	26
	40,000–60,000 KES €265.5–398.3	6
	>60,000 KES €398.3-	1
Average monthly household income		€123.3
Consumption	Tamarind	86 (64%)
	Baobab	44 (44%)
	Coconut	91 (67%)
	Two products	51 (38%)
	Three products	18 (13%)
Household size		4,6 (range 1–11)

The average exchange rate was 0.006638 Euros (≈ €0.006638) per Kenyan Shilling in December 2023.

overlapping supply chains, differing in geographic reach, product form, and exposure to seasonal constraints (Fig. 1). Baobab is primarily sourced from Kenya's Eastern Province, Kilifi, and the wider Coast region, with occasional imports from Tanzania, and traded mainly as raw seeds, powder, and sugary processed snacks. Coconut sourcing is more geographically concentrated along the Kenyan coast, particularly in Kilifi, Kwale, Taita Taveta, and Lamu, with products differentiated by maturity stage—immature coconuts (madafu and koroma) for beverages and mature coconuts (nazi) for cooking and processing. Tamarind, by contrast, is supplied largely from semi-arid inland regions such as Kitui, Meru, Tharaka Nithi, and Makueni, with supplementary imports from Uganda during the rainy season.

Across all three products, open markets in Mombasa such as Marikiti and Kongowea dominate retail exchange, serving both household and restaurant buyers. However, demand structures differ; coconut is overwhelmingly purchased by restaurants and households, whereas baobab and tamarind are more evenly split between direct consumption and small-scale processing or resale. Traders reported product-specific challenges, including rainy-season degradation and rising sugar costs for baobab, and strong seasonality, price volatility, and weak packaging and storage for tamarind.

4.3. Uses and practices in restaurants

A summary of the Restaurant use of Coconut and Tamarind is shown in Tables 4a and 4b

In restaurants, coconut is a core ingredient used primarily in savoury dishes such as beans, rice, fish, and doughnuts, functioning both as a flavour enhancer and a binding agent (Tables 4a and 4b). Use practices are highly standardised, with most restaurants relying on fresh coconut milk and distinguishing between light milk added early in cooking and thick milk used for finishing. While processed coconut cream and oil are increasingly adopted for convenience and shelf life, fresh grated coconut remains dominant due to perceived superior taste and quality.

Quality perceptions centre on maturity and flesh yield: preferred coconuts are mature, dry, dark brown, and heavy, with thick white flesh and minimal water. Distinctions are also made between mature coconuts for cooking and young coconuts (madafu) for beverages. Suggested improvements focused on strengthening local supply, improving packaging (e.g. milk in packets), ensuring harvesting at full maturity, and expanding value-added coconut products.

As a sauce, tamarind adds tangy depth to seafood, meats, and vegetarian dishes, and serves as a flavourful dip for snacks. Tamarind juice, naturally sweet-sour and refreshing, is offered as a cooling beverage in the city's hot climate. Restaurants prepare both traditional and modern variations, highlighting tamarind's versatility and its role as a signature ingredient in the region's food culture. Preparation involves several steps to obtain the tasty pulp. Ingredients and spices add to the flavour of the cold juice or the sauces that accompany dishes or serve as dips.

Tamarind use in restaurants is largely increasing, driven by strong demand for juice, particularly during hot seasons and among Swahili communities, where it is valued for taste, affordability, and perceived health benefits. Use expands when supply is reliable and prices are low, enabling the preparation of both beverages and sauces. Conversely, seasonality, high transport and sugar costs, and financial constraints limit consistent use and lead some eateries to reduce production.

Quality is primarily defined by freshness and pod colour: light brown, fresh pods are preferred for juice, while darker, mature pods are favoured for sauces due to their stronger flavour. Restaurants identified supply expansion, hygienic packaging, value-added products, and flavour innovations as key opportunities to improve availability, consistency, and market appeal.

4.4. Uses and practices in households

A summary of the household answers is presented in Tables 5a and 5b and commented upon in the following text.

Tables 5a and 5b show that while baobab, tamarind, and coconut share routine-based sourcing through local markets and shops, they play distinct roles in household consumption.

A central contrast lies in how the products are used. Baobab is primarily consumed as an occasional snack (Mabuyu[1]), associated with children, taste preferences, and cravings rather than with main meals. In contrast, coconut and tamarind are embedded in everyday food preparation practices. Coconut functions as a staple cooking ingredient in coastal cuisine, providing richness and structure to dishes such as rice, beans, fish, and snacks. Tamarind, while used in smaller quantities, plays a regular role as a flavouring and beverage ingredient, valued for its distinctive sweet–sour taste and versatility in sauces and juices.

Consumption frequency differs across the three products. Coconut and tamarind are in higher proportions used weekly or daily in many households, aligned with habitual cooking routines and culturally defined dishes. Baobab consumption is more occasional, fluctuating with availability, affordability, and children's demand. Hence, coconut and tamarind are used weekly or daily in many households, while baobab is consumed mainly on an occasional basis.

Across all three products, sourcing is overwhelmingly local, indicating that purchasing is embedded in everyday routines rather than planned shopping. Reliance on neighbourhood shops and open markets reflects convenience, trust, and the informal nature of urban food provisioning. Even when supermarkets are accessible, households largely

[1] Sweets from Baobab seeds

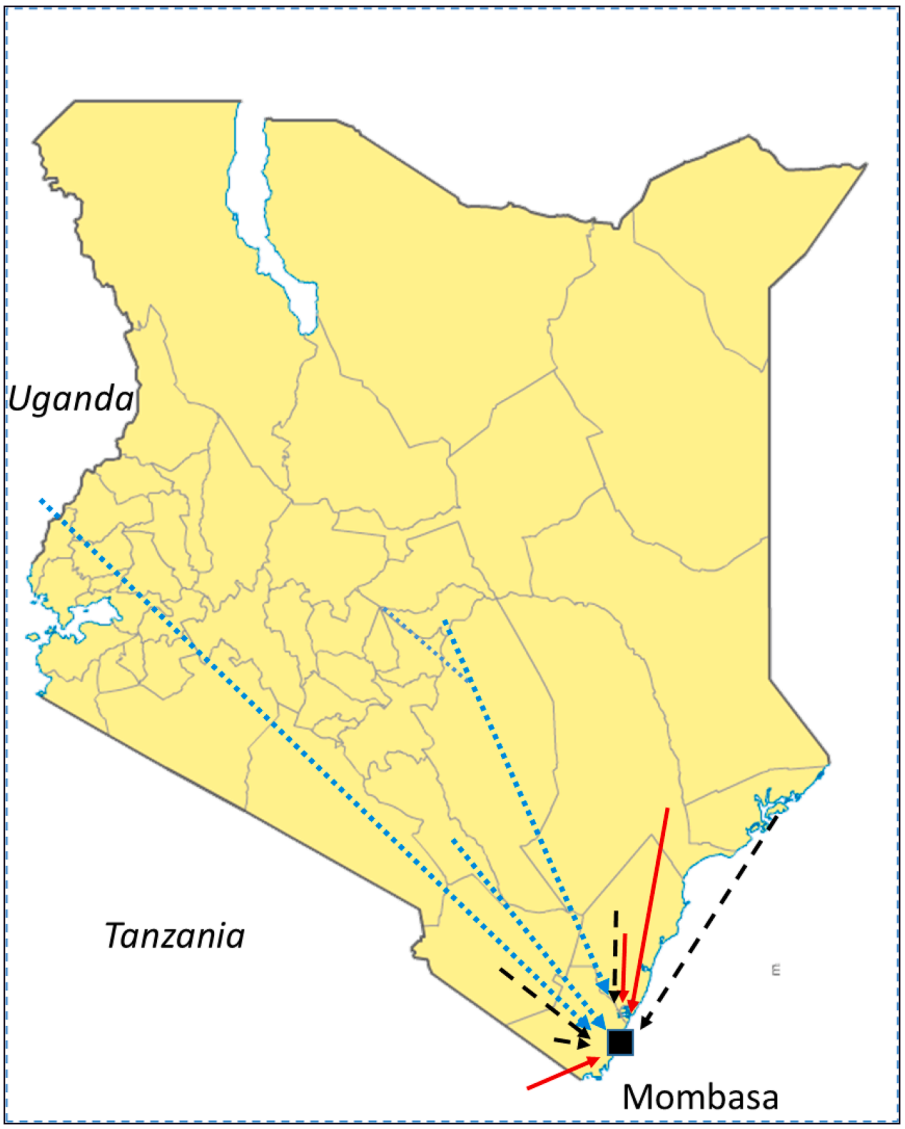

Fig. 1. Trade flows to Mombasa of, respectively, baobab (Red solid arrows), coconut (black dashed line), and tamarind (blue dotted line).

favour traditional retail channels, reinforcing the role of proximity and habit in food acquisition.

Quality perceptions further illustrate shared expectations alongside product-specific criteria. Households consistently emphasise freshness, cleanliness, and absence of spoilage, but assess quality through different cues: maturity and flesh yield for coconut, moisture and colour for tamarind, and powder content and appearance for baobab snacks. These criteria are intricately linked to intended use, indicating that quality is judged pragmatically in relation to cooking performance, taste, and suitability for children.

Improvement needs point to common challenges and differentiated opportunities. Across products, households call for better packaging, more consistent quality, and improved hygiene, highlighting weaknesses in informal value chains. At the same time, desired improvements diverge; coconut users emphasise mature harvesting and ready-to-use milk products; tamarind users seek convenient, shelf-stable sauces and juices; and baobab users' express interest in reduced sugar content and diversified products such as beverages and health-oriented snacks.

In terms of future potential, coconut shows the strongest scope for upgrading as a premium and convenience-oriented staple, if price volatility and seasonal supply constraints are addressed. Tamarind exhibits growing demand linked to health awareness, convenience, and versatility, suggesting strong prospects for value-added products.

4.5. Household perceptions of baobab, coconut, and tamarind

4.5.1. Attribute-level perception scores

Table 6 presents the mean scores of respondents' perceptions across the three food products (baobab, coconut, and tamarind) for each attribute and indicates where statistically significant differences exist between the products. Differences were tested using pairwise comparisons of column means under the assumption of equal variances, with significance determined at the 5% level and adjustments made using the Bonferroni correction. The results in Table 6 are also illustrated in Fig. 2.

Table 6 and the web diagram (Fig. 2) illustrate the distinct perception profiles of the TFAPs across thirteen attributes. Regarding practical attributes, tamarind was rated significantly higher for convenience in buying and preparation compared to coconut. Both baobab and tamarind were perceived as more energy-saving than coconut ($p < 0.05$, Table 6). Coconut achieved the highest mean scores for sensory and cultural aspects, being rated as the most pleasurable, natural, and familiar, as well as the product most strongly associated with Kenyan identity. While tamarind followed coconut closely in pleasure and naturalness, baobab was rated as the most affordable—significantly

Table 4a
Restaurant use intensity, quantities, prices, and seasonal trends for coconut and tamarind.

Category / Variable	Coconut	Tamarind
Usage Metrics		
Number of respondents	54	47
Monthly quantity (mean)	92 coconuts	5 kg
Use trend	Mixed (↑ demand; ↓ price & supply constraints)	Increasing (juice demand; versatility)
Trend Drivers		
Factors for increase	Customer demand (9); taste (5); supply stability (4); affordability (2); health appeal (2)	Health value (9); demand (6); supply (5); affordability (4); taste/culture (6)
Factors for decrease	High price (15); low supply (10); seasonality/transport/ quality (6)	Weather/seasonality (5); transport & sugar costs (5); demand/business constraints (5)
Market Data		
Main use form	Cooking (beans, rice, fish); doughnuts; flavouring; oil	Juice; sauces; snack dips
Average unit price	€0.34 / coconut	€0.52 / kg
Seasonality		
High availability (Price)	Jun–Sep (€0.13–0.33 / coconut)	Jan–Apr (€0.13–0.30 / kg)
Low availability (Price)	Dec–Mar (€0.46–0.93 / coconut)	Jun–Nov (€0.66 / kg)

Table 4b
Restaurant practices, quality criteria, and improvement needs.

Category / Variable	Coconut	Tamarind
Preparations	Grating/blending → straining to milk; staged use (light vs thick milk); use of processed cream/oil	Soaking → mashing → straining; flavoured juice; spiced sauces
Quality Signs	Maturity (dry, brown, hard); flesh quantity; sweetness; absence of defects	Colour (light/dark brown); freshness & moisture; juice yield; taste
Product Varieties	Young (madafu) vs mature; size; processed vs raw	Light/fresh vs dark/mature pods (sometimes mixed light and dark)
Suggested Improvements	Packaging & storage; value addition; mature harvesting; local cultivation	Packaging & hygiene; value-added products; quality consistency; flavour innovation

higher than coconut and statistically similar to tamarind. Perceptions of environmental benefits were significantly higher for coconut and tamarind than for baobab. Finally, while baobab and coconut were both positively rated for child suitability, tamarind received a significantly lower score in this category.

4.5.2. Perception components identified by principal component analysis

Principal Component Analysis (PCA) was used to reduce the dimensionality of the perception data and to identify underlying structures in consumer evaluations.

The Kaiser–Meyer–Olkin measure (0.758) indicated satisfactory sampling adequacy, and Bartlett's Test of Sphericity was significant ($\chi^2 = 908.652$; $df = 78$; $p < 0.001$), confirming the suitability of the data for factor analysis. Four components were retained based on the eigenvalue-greater-than-one criterion. A factor loading threshold of 0.50 was applied to ensure robust and interpretable results (Hair et al., 2010). The four components together explained approximately 64% of the total

Table 5a
Household characteristics.

Category / Variable	Baobab	Coconut	Tamarind
Sample Profile			
Number of households	44	91	86
Gender (% Female/Male)	44 / 56	59 / 41	69 / 31
Mean age (years)	40.5	41.0	40.5
Education (Secondary or higher)	30	64	58
Mean household income/month/ person	€41.2	€32.8	€27.7
Market Dynamics			
Primary Sourcing Channels	Local shops, open markets, supermarkets	Local shops, markets, producers/ hawkers	Markets, local shops, occasional direct sourcing
Main Household Use	Snacks, juice, small-scale sale	Cooking (milk-based dishes), doughnuts	Sauces, juice, flavoring
Commercial Activity (%)	13% produce and sell	4% produce and sell	13% produce and sell

variance, with Component 1 explaining 20%, Component 2, 18%, Component 3, 13%, and Component 4, 13%. Varimax rotation was applied to enhance interpretability. Following common practice in multivariate analysis, a factor loading threshold of 0.50 was applied to ensure that only strong and practically meaningful associations were retained (Hair et al., 2010). The resulting rotated component structure is presented in Table 7.

As shown in Table 7, the analysis yields four clearly interpretable components. The PCA provides further insight into how urban consumers evaluate TFAPs and why these evaluations translate into different consumption patterns. Rather than reflecting a single underlying attitude toward tree-based foods, the four identified components capture distinct logics through which products are assessed and incorporated into everyday life. This reinforces the view that urban TFAP consumption is multi-dimensional and practice dependent. The first component, labelled *Cultural and Environmental Identity*, reflects products embedded in local food culture. It loads on Kenyan identity, environmental benefits, and familiarity, while also showing positive loadings for preference and affordability. The second component, *Health and Wellbeing*, is defined by high loadings for family health, family mood, and naturalness, and is also associated with preference. The third component, *Family and Sensory Enjoyment*, captures suitability for children and pleasure, but exhibits a negative correlation with affordability, suggesting a perception as "premium treats". Finally, the fourth component, *Preparation Effort and Utility*, focuses on convenience and energy saving, while showing a negative correlation with the ability to reduce hunger, indicating a trade-off between convenience and satiation.

4.5.3. Comparative performance across perception dimensions

The distinct perception profiles of the three TFAPs across the four identified perception dimensions are presented in Table 8 and illustrated in Fig. 3. As these factor scores represent standardized positions along latent constructs rather than raw attribute means, small differences between products should be interpreted with caution.

Fig. 3 compares the three TFAPs regarding the four PCA-derived dimensions *Cultural and Environmental Identity, Health and Wellbeing, Family and Sensory Enjoyment,* and *Preparation Effort and Utility.*

The comparative analysis of the three products across the identified perception dimensions reveals distinct profiles that influence their roles in urban households. Regarding *Cultural and Environmental Identity*, there are no statistically significant differences between baobab,

Table 5b
Practices, quality criteria, and improvement needs.

Category / Variable	Baobab	Coconut	Tamarind
Usage & Preparation			
Preparation Methods	Processed snacks; syrup-based boiling; juice mixing	Grating/blending → milk extraction; staged cooking	Soaking → straining; spiced juice or sauces
Consumption Frequency (%)	14 Daily / 36 Weekly / 50 Monthly	32 Daily / 54 Weekly / 14 Monthly	28 Daily / 63 Weekly / 9 Monthly
Mean Monthly Quantity	4.49 kg (s.d. 0.12)	3.10 pieces (s.d. 0.14)	1.14 kg (s.d. 1.37)
Economics & Trends			
High Season Price	€0.39/kg (Jan–Apr)	€0.33/piece (Jun–Sep)	€0.27/kg (Jan–Apr)
Low Season Price	€0.71/kg (June–Nov)	€0.76/piece (Dec–Mar)	€0.80/kg (June–Nov)
Consumption Trend (%)	29.5 Increase / 59.1 Stable	37.4 Increase / 39.6 Stable	38.4 Increase / 48.8 Stable
Quality & Improvements			
Key Quality Indicators	Creamy/light powder; large well-filled seeds; fresh appearance	Large/heavy; dry dark brown shell; thick white flesh	Light to golden brown; fresh/moist; high juice yield; sweet-sour balance
Desired Improvements	Better packaging; reduced sugar; value-added supplements	Consistent quality; packaging for milk; development of new products	Extended shelf life; ready-to-use forms; promotion of health benefits

Table 6
Means perceptions by respondents.

	Baobab	Coconut	Tamarind
Truly Kenyan	7.0_a	8.2_b	7.4_a
Nature Environment	6.7_a	7.8_b	$7.6_{a,b}$
Familiar	7.4_a	8.5_b	$8.0_{a,b}$
Family Health	5.9_a	8.2_b	7.9_b
Family Mood	6.7_a	7.6_a	7.2_a
Natural	7.0_a	8.8_b	8.7_b
Children	8.1_a	7.4_a	4.4_b
Pleasure	7.7_a	8.5_b	7.6_a
Preference	7.2_a	8.6_b	8.3_b
Convenient to Buy and Prepare	7.4_a	6.4_b	8.3_a
Energy Saving	7.0_a	5.6_b	7.8_a
Affordable	8.1_a	6.2_b	8.0_a
Reduce Hunger	5.3_a	5.1_a	4.5_a

Values in the same row not sharing the same subscript are significantly different at $p < 0.05$ (Two-sided test).
1. Tests are adjusted for all pairwise comparison.

coconut, and tamarind; all three are viewed as symbolically embedded in local food culture. However, clear distinctions emerge in other areas. In the dimension of *Health and Wellbeing*, both coconut and tamarind scored significantly higher than baobab ($p < 0.05$). This indicates a stronger consumer association with perceived health benefits and naturalness, which helps explain their regular integration into daily household routines, whereas baobab consumption remains more episodic. When examining *Family and Sensory Enjoyment*, coconut achieved the highest positive score, reflecting its central role in creating pleasurable family meals. Baobab occupies an intermediate position between coconut (highest) and tamarind (lowest) in this dimension. Finally, in terms of *Preparation Effort and Utility*, tamarind stands out as significantly more convenient and energy-saving to prepare than both coconut and baobab. This strong performance highlights tamarind's compatibility with time-constrained urban lifestyles. Conversely, the lower scores for coconut underscore that its labour-intensive preparation—specifically the traditional requirements of grating and straining—remains a significant barrier for modern consumers despite its popularity in other dimensions.

5. Discussion

5.1. Key findings and comparison with existing literature

This study provides nuanced insights into the supply chains, uses, and consumer perceptions of baobab, coconut, and tamarind in Mombasa city, a key hub for local, national, and international trade. Rather than treating TFAPs as a homogeneous category, the findings demonstrate how urban consumption differentiates products into staples, flavouring agents, and snacks, each embedded in distinct social practices. All three tree- and forest-based products (TFAPs) are regionally sourced:

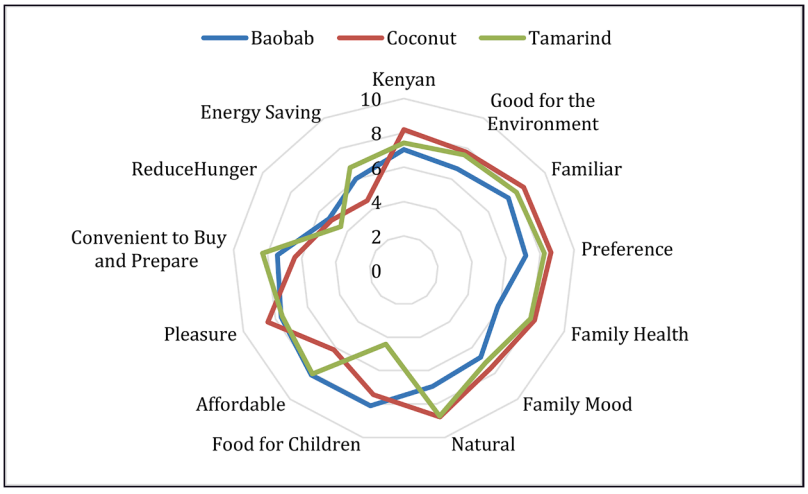

Fig. 2. Consumer perceptions of baobab, coconut, and tamarind across individual thirteen attributes (Likert scale 1–9).

Table 7
Rotated component matrix.

	Component			
	1. Cultural and Environmental Identity	2. *Health and Wellbeing*	3. *Family and Sensory Enjoyment*	4 *Preparation Effort and Utility*
Kenyan	0.797			
Good for the Environment	0.767			
Familiar	0.729			
Preference	0.567	0.554		
Family Health		0.869		
Family Mood		0.678		
Natural		0.676		
Children			0.752	
Affordable	0.556		−0.604	
Pleasure			0.567	
Convenient to Purchase & Prepare				0.754
Reduce Hunger				−0.742
Energy Saving				0.524

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalisation.

Table 8
Mean scores and differences across perception dimensions across the thirteen attributes.

	Baobab	Coconut	Tamarind
Cultural and Environmental Identity	0.083_a	-0.020_a	-0.022_a
Health and Wellbeing	-0.991_a	0.233_b	0.261_b
Family and Sensory Enjoyment	-0.044_a	0.629_b	-0.643_c
Preparation Effort and Utility	-0.242_a	-0.251_a	0.389_b

Note: Values in the same row not sharing the same subscript are significantly different at $p < 0.05$ in the two-sided test of equality for column means. Tests assume equal variances.[1].
1. Tests are adjusted for all pairwise comparisons within a row of each innermost suitable using the Bonferroni correction.

baobab from Eastern Kenya and Tanzania, coconut from the coastal belt, and tamarind from Eastern Kenya and Uganda. Despite these diverse sources, market flows are constrained by seasonality, inconsistent quality, rising costs, and inadequate packaging and storage, particularly for baobab and tamarind.

Coconut dominates culinary use in both households and restaurants, being incorporated into staple dishes through milk, cream, or oil, although price and availability influence consumption patterns. Tamarind is valued for its versatility, being used in juices, sauces, and porridges, with increasing adoption in restaurant menus. Baobab's current role lies in being a valued snack, but it has also potential for product transformation in urban health and wellness markets. It remains largely niche, primarily consumed as a nostalgic snack for children or as an occasional juice ingredient.

Overall, coconut emerges as the most positively perceived product, consistently scoring high on health, sensory appeal, cultural importance, and overall preference. Baobab, although less strongly associated with health and environmental benefits, is appreciated for its affordability, suitability for children, and ease of preparation. Tamarind is valued for its convenience, naturalness, and environmental friendliness, but its low rating for children's consumption suggests a perception barrier in that area.

Consumer perceptions cluster around four dimensions: cultural and environmental value, health, child-related and hedonic appeal, and practical convenience. Coconut is rated highest for health benefits, naturalness, and enjoyment; tamarind is favoured for health and ease of preparation; and baobab is appreciated for affordability and cultural identity. These findings suggest that urban consumption is shaped by a complex interplay of sensory, social, and practical considerations, where taste, tradition, nutrition, and convenience intersect to guide consumer behaviour.

The relatively low health perception of baobab observed in this study is inconsistent with findings in other contexts, such as Sudan (Saeed et al., 2023), where the product is perceived primarily as a healthy food. This divergence likely does not reflect the intrinsic nutritional properties of the fruit, but rather the dominance of sugar-sweetened processed forms in the Mombasa market. This indicates that value-chain characteristics—particularly processing and product formulation—shape not only consumption patterns but also consumer perceptions, potentially masking the product's nutritional potential.

Compared with existing research, this study contributes to the understanding of TFAP consumption by moving beyond traditional analyses of market participation, attitudes, or willingness-to-pay. Previous African studies have largely emphasized supply-side constraints, household engagement, and trade dynamics (Amusa et al., 2017; Mahonya et al., 2019), or evaluated consumer attitudes toward specific products such as baobab (Agúndez et al., 2018; Saeed et al., 2023; Horlu et al., 2023). While these studies demonstrate positive perceptions,

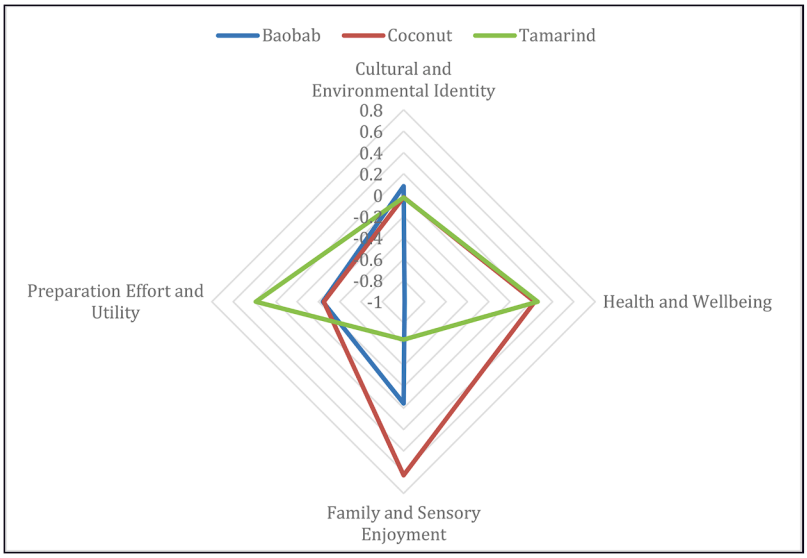

Fig. 3. Perception profiles of baobab, coconut, and tamarind across the four dimensions.

needs for market development (Mutua et al., 2023) and latent demand, they offer limited insight into how products are used, prepared, or incorporated into daily urban diets.

Viewed through the combined lenses of consumer theory, social practice theory, and the 5P framework, the findings reveal that urban TFAP consumption is driven by both attribute-based evaluations and the degree to which products are embedded in everyday food practices. Consumer theory explains observed differences in preference through attributes such as taste, health, and visual aspects, while social practice theory clarifies why only some positively perceived products—particularly coconut and tamarind—are regularly consumed. This is reflected in their integration into routine cooking and beverage practices. The 5P framework highlights how these differences translate into distinct opportunities for value addition and market development, underscoring the need to align product improvements and marketing strategies with existing urban practices.

Consumption appears influenced by practical knowledge, cooking skills, affordability, and convenience. This aligns with research on indigenous vegetables in African cities emphasizing quality, hygiene, and price as key determinants of urban food choices (Shafiwu et al., 2018; Alphonce et al., 2025). Yet, Mombasa's urban consumers display cultural narratives around tree-based products, although not to the same degree as in South Asian gum-resin markets where spiritual and cultural significance strongly drives demand (Soumya et al., 2025). Thus, urban TFAP consumption cannot be fully explained through market access, price, or nutrition alone; it is embedded in everyday practices of cooking, sharing, and knowledge transmission.

5.2. Implications of the findings on improvement of the products

Building on the empirical findings and theoretical synthesis above, this section outlines key implications for urban markets, value-chain actors, and policy. The improvement opportunities presented below are based on observed consumer perceptions and practices interpreted through consumer theory, social practice theory, and the 5P framework. Although the study does not assess producer incomes or forest outcomes directly, the findings point to plausible mechanisms through which urban demand may incentivise value addition and market development along TFAP value chains.

The study highlights significant opportunities for urban-oriented marketing and product development strategies that leverage the distinct attributes of each TFAP. Coconut's entrenched role as a cultural and culinary staple provides a platform for branding that emphasizes tradition, health, and premium quality. Innovations such as ready-to-use coconut milk in sachets or cartons could reduce preparation time for busy households while highlighting sustainable sourcing to appeal to environmentally conscious consumers. Tamarind's versatility aligns with urban lifestyles that value convenience and wellness. Ready-to-drink beverages, spiced sauces, and health-focused products could capitalize on functional food trends and promoting tamarind's digestive and medicinal properties would strengthen its health positioning. Packaging improvements that ensure freshness, hygiene, and visual appeal are critical for wider adoption in both households and restaurants.

Baobab represents both a challenge and an opportunity. Traditionally consumed as a nostalgic children's snack, its appeal could be broadened to urban health-conscious consumers through value-added products such as energy bars, powdered supplements, or functional beverages, ideally with reduced sugar content. Branding should maintain nostalgic and affordable elements while targeting new segments seeking functional and nutritious products, as suggested by Meinhold (2023). In restaurants, integrating baobab into desserts, beverages, and innovative menu items could enhance visibility and normalize consumption beyond children's snacks.

Together, the findings reveal complementary roles of the three TFAPs in Mombasa's urban food culture, with consumer perceptions shaped by a balance of cultural identity, health benefits, child/family enjoyment, and preparation-related utility.

Table 9 summarizes branding characteristics and potential improvements for baobab, tamarind, and coconut in restaurants and households. Successful urban marketing should combine differentiation, convenience, health benefits, sensory appeal, and cultural resonance, aligning product development with consumers' preparation practices, tastes, and social meanings.

The study also underscores the pivotal role of low-income rural producers in translating urban TFAP demand into sustainable livelihoods. Producers can strengthen market participation by prioritizing quality consistency, including harvesting mature coconuts, sorting tamarind pods by ripeness for culinary uses, and supplying clean, powder-rich baobab fruits. Basic value addition at the rural level—presorting, cleaning, drying—extends shelf life, improves hygiene, and enhances marketability. Cooperative models could facilitate small-scale processing for semi-processed products such as baobab snacks, tamarind concentrates, or grated coconut, bridging the gap between rural supply and urban consumer convenience. Additionally, rural producers can engage in branding and storytelling emphasizing health, cultural heritage, and environmental sustainability, using simple labels such as "traditional," "community-grown," or "natural" to differentiate their products. Ecological sustainability through replanting and responsible harvesting is critical to ensure long-term supply and appeal to environmentally conscious consumers. The identified potential area for improvement for baobab is branding to enhance its marketability based on its health benefits. The cooking experience for tamarind and coconut can be enhanced through improved packaging, quality development, and value addition.

Policymakers play an essential role in fostering sustainable TFAP markets. Investment in tree regeneration, provision of improved seedlings, and extension services promoting sustainable harvesting are key to maintaining supply. Establishing quality standards, certification systems, and labelling requirements enhances consumer trust and opens opportunities in formal retail and export channels. Inclusive value chain policies that integrate women, youth, and small-scale producers, coupled with access to finance, cooperative support, and infrastructure such as cold storage and processing facilities, can stabilize supply, reduce post-harvest losses, and improve livelihoods. Supporting research, innovation, and market development further promotes product diversification, competitiveness, and stronger linkages between producers and urban consumers.

5.3. Limitations and future research

The study's geographic focus on Mombasa city, reliance on self-reported household and restaurant data, seasonal constraints during data collection, and concentration on three TFAPs may limit generalizability. In particular, as a single-city case study, the sample may not be fully representative of the diversity of consumers and market actors across Mombasa city. Furthermore, the direct transferability of the findings to other African urban contexts is limited, as the main TFAPs, trade patterns, and food practices most likely differ between locations. Future research should adopt multi-city comparative approaches, longitudinal designs to capture seasonality and climate impacts, and experimental assessments of consumer willingness to pay for value-added products such as fortified baobab beverages or packaged coconut milk. Integrating ecological and conservation perspectives into market research will be critical to ensure that urban demand supports both livelihood improvements and sustainable management of TFAP resources in rapidly urbanizing African contexts.

6. Conclusions

Tree-based forest and agroforestry products (TFAPs) play differentiated but important roles in Mombasa's urban food culture. Coconut

Table 9
Branding characteristics and improvement opportunities across restaurant and household segments (5p framework in parentheses).

Product	Branding Characteristics (Restaurants)	Desired Improvements (Restaurants)	Branding Characteristics (Households)	Desired Improvements (Households)
Baobab	Low menu visibility	Introduce beverages; emphasize health and nostalgia (Product/ Promotion)	Affordable; occasional juice preparation (Price/People)	Better packaging; diversify into healthier, less sweet varieties (Product)
Tamarind	Versatile; cultural and health value	Improve hygienic packaging; ready-to-use sauces (Product/ Place)	Common in sauces; daily-weekly use; high affordability (Price)	Expand into jams; health supplements; promote convenience (Product/ Promotion)
Coconut	High sensory appeal but costly (Price)	Packaged milk/cream; ensure consistent quality (Product/Price)	Culturally Kenyan and habitual; price-sensitive demand Staple in daily meals; culturally Kenyan and habitual; price-sensitive demand (Product/Place/Price)	Improve milk packaging; ensure mature fruits; highlight nutrition (Product/Promotion)

functions as a culinary staple deeply embedded in Swahili cuisine, tamarind is valued for its versatility in sauces and juices, and baobab remains a nostalgic snack closely associated with children. Together, these products illustrate how everyday habits and cultural practices sustain urban demand for TFAPs. With Africa's rapidly growing urban population and potentially rising purchasing power, demand for culturally significant foods is likely to increase, creating opportunities for TFAPs to move from informal street foods into more formal urban markets. This transition is already visible in Mombasa, where supermarkets and restaurants increasingly stock tamarind and coconut products. However, seasonal supply, inconsistent quality, poor packaging, and weak value chains currently constrain this potential of the products, while limited investment in tree regeneration threatens the long-term ecological base.

The findings point to clear opportunities for value addition and targeted marketing. Ready-to-use coconut milk, convenient and health-oriented tamarind products, and diversified baobab snacks could better align with urban consumers' needs for convenience, health, and quality. Policymakers have a critical role in ensuring that expanding demand translates into sustainable livelihoods and ecological benefits. Supporting smallholder inclusion, quality standards, processing infrastructure, and tree regeneration would strengthen value chains while creating income opportunities for women, youth, and traders. Overall, the Mombasa city case demonstrates that urban TFAP markets can contribute to food security, cultural continuity, and sustainable livelihoods if supported by inclusive, well-functioning value chains and ecological stewardship.

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Declaration of generative AI use

During the preparation of this work the authors used Chat GPT, developed by OpenAI, to improve the language and clarity of the text. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

CRediT authorship contribution statement

Anders Roos: Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Doris Mutta:** Writing – review & editing, Validation, Project administration, Investigation, Conceptualization. **Chemuku Wekesa:** Writing – review & editing, Validation, Project administration, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Sauda Abubakar:** Writing – review & editing, Methodology, Investigation, Data curation. **Okumu, Saggafu Mwanahalima:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Marie Louise Avana-Tientcheu:** Writing – review & editing, Validation, Conceptualization. **Cecilia Mark-Herbert:** Writing – review & editing, Validation, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no competing interests.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tfp.2026.101269.

Appendices

Appendix A. Perception attributes used in the survey

Perception attribute
Tamarind/Baobab/Coconut (the food product) is good for my family's health (FH)
Baobab/Coconut/Tamarind is good for the family's mood (FM)
Baobab/Coconut/Tamarind reduces the hunger feeling (HF) well
Baobab/Coconut/Tamarind is convenient in buying and preparing
Baobab/Coconut/Tamarind gives pleasure through texture, appearance, taste, smell
Baobab/Coconut/Tamarind is natural
Baobab/Coconut/Tamarind is affordable
Baobab/Coconut/Tamarind is familiar. It is a part of our culture and tradition
Baobab/Coconut/Tamarind product is good for the nature and the environment (NE)
I like Baobab/Coconut/Tamarind
I view Baobab/Coconut/Tamarind as truly Kenyan
Baobab/Coconut/Tamarind consume little energy to prepare/Energy saving
Baobab/Coconut/Tamarind is a suitable food for children

Data availability

Data will be made available on request.

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