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Post-Harvest Deterioration and Loss Management Practices of African Indigenous Vegetables Across Urban Value Chains in Cameroon

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Abstract

Post-harvest deterioration remains a persistent constraint on the availability, quality, and economic value of African indigenous vegetables in Cameroon. Much of the existing literature documents, in general terms, that heat, poor storage, and transport delays drive such losses; less evidence exists on whether exposure to these mechanisms differs systematically, and statistically significantly, across value-chain actors. This study assessed post-harvest handling practices, causes and signs of deterioration, and loss-reduction strategies for *Vernonia amygdalina, Vernonia hymenolepis, Solanum scabrum*, and *Solanum lycopersicum* among producers, traders, processors/handlers, and consumers in five urban centres of Cameroon (Yaoundé, Buea, Douala, Bamenda, and Bafoussam), using a structured, researcher-facilitated digital questionnaire administered to 71 respondents. Beyond descriptive statistics, chi-square tests of independence and a logistic regression were used to test whether respondent category is significantly associated with reported loss causes, deterioration signs, and coping strategies. High temperature/humidity (59%) and poor storage conditions (55%) were the most frequently reported causes of loss overall, and respondent category was significantly associated with reporting poor storage as a cause ($\chi 2 = 14.01$, $p < 0.001$), transportation delays ($\chi 2 = 9.36$, $p = 0.009$), wilting ($\chi 2 = 12.22$, $p = 0.002$), discoloration ($\chi 2 = 7.54$, $p = 0.023$), and use of refrigeration ($\chi 2 = 9.74$, $p = 0.008$). In logistic regression, producers showed markedly higher odds of reporting poor storage as

a cause of loss than consumers (OR = 4.16, p = 0.055), while processors/handlers showed significantly lower odds (OR = 0.26, p = 0.034); years of experience was not a significant independent predictor. These findings provide statistical, not merely descriptive, evidence that post-harvest loss exposure is structured by value-chain position, and indicate that interventions should be targeted by actor group, with producers a priority for storage and transport infrastructure investment, rather than applied uniformly. The study is limited by its non-probability sampling approach and modest sample size; findings should be interpreted as indicative rather than nationally representative, and are intended to inform a broader PhD research programme on nutritional and biochemical changes in these vegetables during processing and storage.

Keywords: Post-Harvest Deterioration, African Indigenous Vegetables, *Vernonia hymenolepis*, Value Chain, Cameroon, Actor-Differentiated Loss, Chi-Square Analysis.

Introduction

Post-harvest losses remain one of the most persistent constraints on food security and rural livelihoods in sub-Saharan Africa, with the reduction of such losses widely recognised as a pathway to improved food and nutrition security (Sheahan and Barrett, 2017). Losses are typically most severe for highly perishable leafy vegetables that lack cold-chain infrastructure between harvest and consumption; in tropical environments such as Cameroon, elevated ambient temperature and humidity accelerate senescence, microbial spoilage, and moisture loss in leafy produce within hours of harvest, so that a large share of the vegetable crop can be rendered unmarketable before it reaches the consumer (Kader, 2002).

African indigenous vegetables, including *Vernonia amygdalina* (bitter leaf), *Vernonia hymenolepis* (a closely related bitter-leaf species locally referred to as sweet bitter leaf), *Solanum scabrum* (huckleberry/black nightshade), and the widely cultivated exotic *Solanum lycopersicum* (tomato), are central to household nutrition and to informal-sector livelihoods across Central and East Africa. Despite their importance, evidence on quantitative and qualitative post-harvest losses along African indigenous vegetable value chains remains limited and methodologically inconsistent (Kubitza et al., 2025), and dedicated research on transport, distribution, and coordination constraints in these value chains is similarly scarce (Alulu et al., 2023). Studies from East Africa indicate that African nightshade (*Solanum scabrum*) can lose a substantial share of its nutritional value and physical quality between harvest and market, with losses shaped by handling method, storage duration, and market chain length (Gogo et al., 2017; Kirigia et al., 2019); comparable losses have been documented for tomato supply chains elsewhere in sub-Saharan Africa, where poor handling, inadequate storage, and transport delays are consistently identified as leading loss drivers (Sibomana et al., 2016). Existing guidance on post-harvest management is,

however, rarely disaggregated by the specific challenges faced by producers as opposed to traders, processors, or end consumers, despite evidence that these actor groups differ systematically in their exposure to loss (Kirigia et al., 2017).

Recent work has begun to look beyond simple ambient storage toward preservation technologies that could realistically be adopted along these value chains. Low-cost precooling and evaporative or solar-powered cold storage units designed for smallholder and market conditions in sub-Saharan Africa have shown consistent gains in shelf life and quality retention for leafy and perishable produce, and are increasingly proposed as an intermediate step between ambient handling and full cold-chain infrastructure (Makule et al., 2022). Complementary approaches, including modified atmosphere and improved packaging, sun and solar drying, and simple on-farm processing into value-added or shelf-stable products, are also being explored as ways to reduce losses where cold storage remains unaffordable or inaccessible. Evidence on how well these innovations perform specifically for African indigenous vegetables such as *Vernonia amygdalina*, *Vernonia hymenolepis*, and *Solanum scabrum*, as opposed to export-oriented or exotic crops, remains limited, and this reinforces the need for context-specific, actor-informed baseline data of the kind this study provides before such technologies can be meaningfully tested or scaled in this value chain.

This study forms part of a broader PhD research programme on the nutritional and biochemical changes that occur in African indigenous vegetables during processing and storage, and on strategies to extend their shelf life. Before biochemical degradation pathways can be meaningfully investigated under controlled conditions, it is necessary to first document what handling practices are actually used in practice, where losses occur, and which actors are most exposed to which risks. The specific objective addressed here was to document and evaluate current post-harvest handling practices for the four target vegetables across the value chain, from harvest to retail, in order to identify critical control points and intervention opportunities that can subsequently be tested experimentally.

Materials and Methods

Study design and sampling

A cross-sectional descriptive survey was conducted using a structured questionnaire administered through Google Forms to individuals involved in growing, trading, processing, or consuming *Vernonia amygdalina*, *Vernonia hymenolepis*, *Solanum scabrum*, and *Solanum lycopersicum* in Cameroon. Respondents were recruited using a non-probability, purposive/snowball approach: initial contacts known to be active in vegetable production, trading, or consumption were identified and engaged directly, and were then invited to share the questionnaire link within their own networks. This approach was chosen because no sampling frame of vegetable handlers exists for these informal value chains; it does not yield a sample that is statistically representative of the underlying population, a limitation discussed in the Limitations section.

Rather than distributing the questionnaire link remotely and passively, most respondents were engaged through direct, in-person contact: the researcher met prospective respondents at their point of business or residence to explain the purpose of the study, build trust, and assist them in opening and completing the digital form on their own device or the researcher's device where needed. This researcher-facilitated model of digital administration was adopted deliberately, as part of an effort to adapt digital data-collection tools to a study population that includes traders and producers with variable levels of digital literacy and smartphone access, while still capturing responses in a structured, directly analysable digital format rather than paper. Hybrid approaches combining face-to-face facilitation with mobile/digital data capture have been shown elsewhere in sub-Saharan Africa to improve respondent comprehension and completion quality relative to either purely self-administered digital surveys or fully paper-based instruments (van Heerden et al., 2013), and the approach adopted here follows that logic while extending it to an agricultural value-chain survey context.

A total of 72 valid submissions were received; one response originating outside Cameroon (Stavanger, Norway, evidently a diaspora respondent commenting on practices outside the study's value-chain context) was excluded as outside the study population, leaving 71 responses for analysis. Respondents were self-classified into four functional categories based on their reported role in vegetable management: Producer/Farmer (n = 18), Trader/Retailer (n = 2), Consumer (n = 30), and Other, comprising processors and general handlers who did not identify primarily as producers, traders, or consumers (n = 21). Several respondents reported combined roles (e.g., farmer and consumer); these were assigned to the category reflecting their primary point of contact with the vegetable (producers before consumers, traders before consumers) so that each respondent contributed to only one category in the subgroup analysis.

Study area

Respondents were drawn from five urban and peri-urban centres spanning four regions of Cameroon: Yaoundé (Centre Region, n = 27), Buea (South-West Region, n = 24), Douala (Littoral Region, n = 5), Bamenda (North-West Region, n = 3), and Bafoussam (West Region, n = 3), with a small number of additional responses from Dschang, Kumba, and Lebialem (n = 1 each) and six responses with unspecified or ambiguous locations. This distribution reflects the actual reach of the survey rather than a designed multi-site sampling plan, and the study is accordingly framed as an exploratory multi-urban assessment of Cameroon's indigenous vegetable value chain rather than a study confined to a single city.

Town of origin is reported here to characterise the geographic reach of the sample and is not used as an analytical grouping variable: towns with very small counts (n = 1-5, i.e. all except Yaoundé and Buea) do not carry sufficient observations to support statistically meaningful town-level comparisons, and no such comparisons are drawn. All subgroup analysis in this study is instead conducted by respondent functional category (producer, trader, consumer, processor/handler; see Study design and sampling), for which the two larger categories (Consumer, n = 30; Other, n = 21; Producer/Farmer, n = 18) support meaningful descriptive

disaggregation; the Trader/Retailer category (n = 2) is retained for completeness but is explicitly flagged wherever discussed as too small to support independent conclusions.

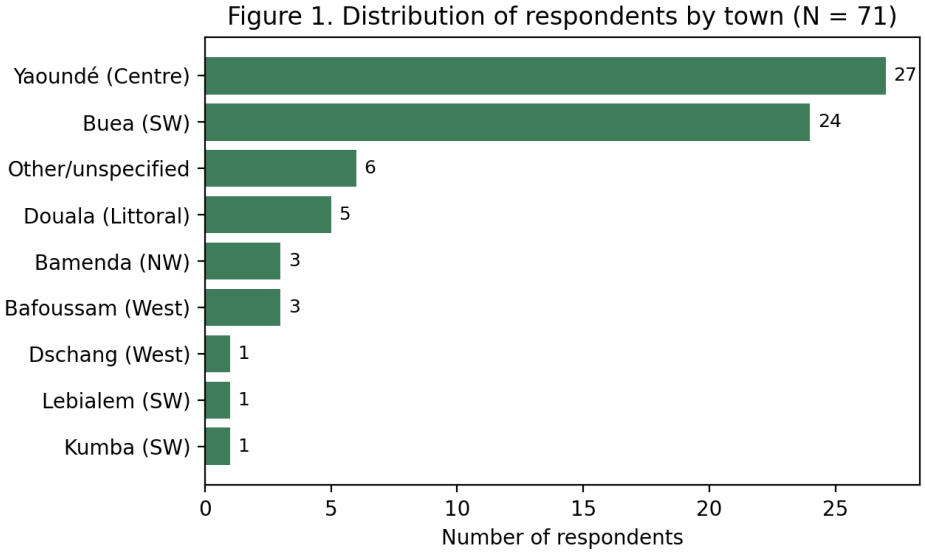

Figure 1. Distribution of respondents by town (N = 71).

Data collection instrument

The questionnaire comprised four sections: (A) respondent information (sex, age, education, functional role, years of experience); (B) post-harvest handling techniques (vegetables handled, harvesting method, post-harvest treatment, packaging, and shelf life under normal conditions); (C) post-harvest deterioration and challenges (causes of loss, visible signs of deterioration, and strategies used to reduce losses); and (D) recommendations for future improvement, including awareness of government/NGO support programmes. Most items allowed multiple responses where respondents used more than one practice; percentages reported for these items therefore do not sum to 100.

Data analysis

Data were exported from Google Forms and cleaned in Python (pandas). Descriptive statistics (frequencies and percentages) were computed for the full sample and disaggregated by the four respondent categories described above, since exposure to specific causes of loss and awareness of deterioration signs were expected to differ systematically between producers, traders, processors/handlers, and consumers. Multiple-response items were coded as independent binary indicators, so that each selected option contributed separately to that item's frequency count; percentages for these items therefore do not sum to 100.

Beyond description, this study tested whether respondent category is statistically associated with reported exposure to specific causes of loss, deterioration signs, and coping strategies. For each binary outcome (e.g., whether a respondent reported poor storage as a cause of loss), a Pearson chi-square test of independence was used to test association with respondent

category (Producer/Farmer, Consumer, Other). The Trader/Retailer category (n = 2) was excluded from inferential testing, as reported in the Study area section, because expected cell counts for this group fall well below the threshold required for a valid chi-square approximation; it is retained in all descriptive tables and figures. Where minimum expected cell counts fell below 5 despite this exclusion, results are flagged accordingly and interpreted with appropriate caution. A binary logistic regression was additionally fitted to test whether respondent category and years of experience jointly predict the odds of reporting poor storage conditions as a cause of loss, the single outcome with the strongest and most consistent association in the descriptive and chi-square analysis; years of experience was coded as an ordinal variable (0 = less than 1 year to 3 = more than 10 years). All statistical tests were conducted in Python (SciPy, statsmodels) with a significance threshold of $\alpha = 0.05$.

Results

Demographic characteristics

Table 1 presents the demographic profile of the 71 respondents. The sample was predominantly female (70%) and had attained higher education (99%), reflecting the recruitment channels used. Respondents were concentrated in the 21-30 age bracket (38%), and a majority (66%) reported more than one year of experience handling the target vegetables, with 39% reporting more than ten years.

Table 1. Demographic profile of respondents (N = 71).

Characteristic	Category	Frequency (n)	Percentage (%)
Sex	Female	50	70.4
	Male	21	29.6
Age (years)	Below 20	16	22.5
	21 – 30	27	38.0
	31 – 40	12	16.9
	41 – 50	9	12.7
	Above 50	7	9.9
Education	Higher education	70	98.6
	Secondary	1	1.4
Experience	Less than 1 year	16	22.5
	1–5 years	23	32.4
	6–10 years	4	5.6
	More than 10 years	28	39.4
Respondent category	Producer/Farmer	18	25.4
	Trader/Retailer	2	2.8
	Consumer	30	42.3
	Other (processor/handler)	21	29.6

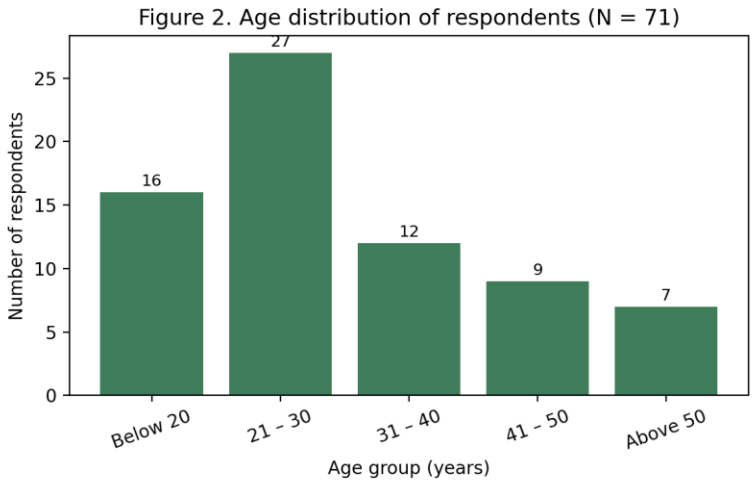

Figure 2. Age distribution of respondents (N = 71).

Vegetables handled and harvesting practices

Tomato (Solanum lycopersicum) was the most commonly handled crop (63%), followed by bitter leaf and sweet bitter leaf (48% each) and huckleberry (39%); many respondents handled more than one crop. Handpicking was the dominant harvesting method (65%), followed by cutting with tools (14%) and a combination of both (14%). After harvest or purchase, washing (61%) and refrigeration (54%) were the most frequently applied handling techniques, while sorting/grading (42%) and sun drying (21%) were less common; chemical preservatives were used by only 10% of respondents. Baskets (44%) and plastic bags (37%) were the dominant packaging materials, with 24% of respondents reporting no packaging at all. Under normal conditions, most respondents (58%) reported that vegetables remained fresh for only 1-2 days, underscoring the high perishability of the study crops and the narrow window available for handling and sale.

Causes and signs of post-harvest loss

Across the full sample, high temperature/humidity (59%) and poor storage conditions (55%) were the most frequently reported causes of post-harvest loss, followed by rough handling (41%), transportation delays (39%), and pests/diseases (38%) (Figure 3). Discoloration (66%) was the most commonly reported visible sign of deterioration, followed by wilting (52%), foul smell (41%), and fungal growth (31%).

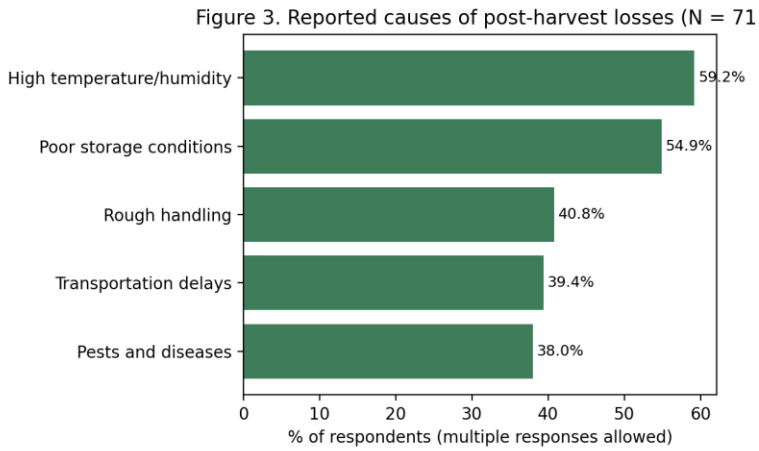

Figure 3. Reported causes of post-harvest losses, full sample (N = 71).

As anticipated, exposure to specific causes of loss differed markedly by respondent category (Figure 4). Producers/farmers reported the highest exposure to poor storage conditions (84%), high temperature/humidity (78%), and transportation delays (68%) of any group, consistent with their direct responsibility for the crop between harvest and sale. Consumers reported comparatively lower but still substantial exposure to these same factors (57%, 60%, and 37% respectively), while the processor/handler group reported the lowest exposure across most causes, plausibly reflecting shorter or more controlled handling intervals.

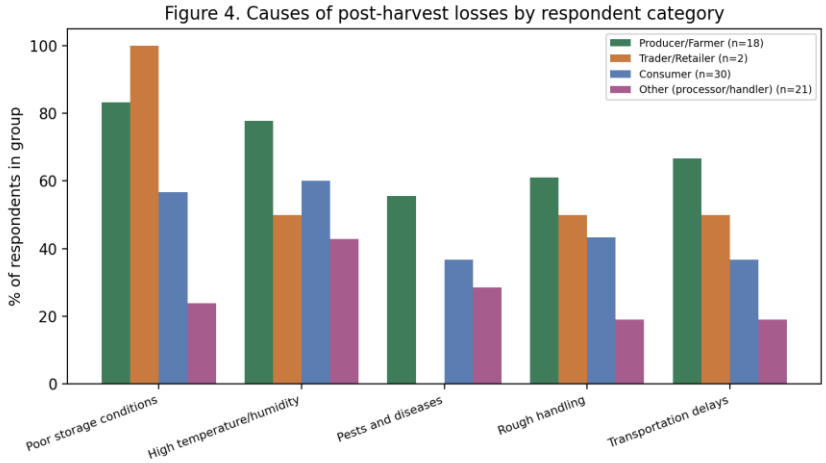

Figure 4. Causes of post-harvest losses by respondent category.

A similar gradient was observed for visible signs of deterioration (Figure 5): wilting was reported by 89% of producers but only 40% of consumers, whereas discoloration was the dominant sign reported by consumers (70%) and traders (100%, n = 2). This pattern is consistent with wilting being most visible at or near the point of harvest, before produce

reaches retail and household level, while discoloration develops and becomes noticeable further along the chain.

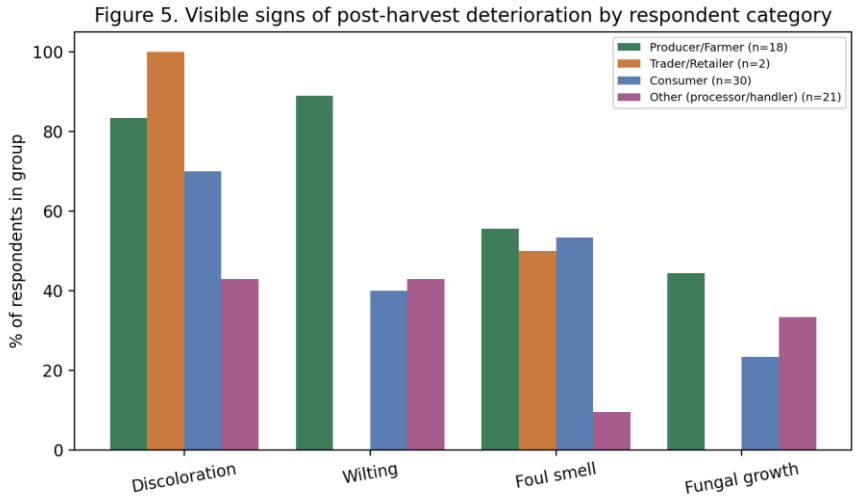

Figure 5. Visible signs of post-harvest deterioration by respondent category.

Post-harvest loss-reduction strategies

Refrigeration was the most widely used loss-reduction strategy overall (55%), followed by improved storage techniques (47%), quick transportation to markets (44%), and drying/processing (39%) (Figure 6). Strategy use also varied by respondent category: producers relied most heavily on refrigeration (74%) and improved storage (68%), while the processor/handler group made comparatively less use of any single strategy, and traders (n = 2) relied primarily on quick transportation.

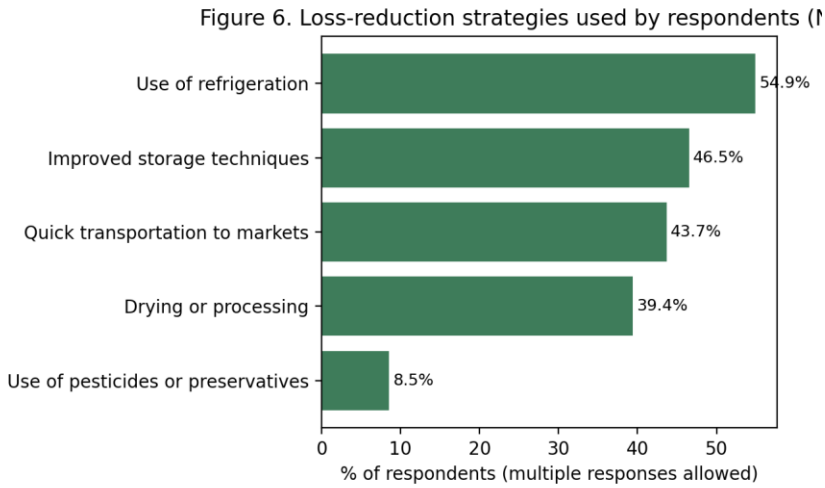

Figure 6. Loss-reduction strategies used by respondents (N = 71).

Challenges and recommendations

Lack of training on post-harvest handling (58%) and lack of storage facilities (54%) were the two most frequently cited challenges, followed by high transportation costs (24%) and poor market access (19%). Only 27% of respondents reported awareness of any government or NGO programme supporting post-harvest management, and of these, training programmes and financial support were the most commonly cited forms of assistance received. When asked what would help reduce losses, respondents most frequently called for training programmes (63%), improved storage infrastructure (50%), and better transportation systems (39%).

Statistical association between respondent category and post-harvest outcomes

To move beyond description, chi-square tests of independence were used to test whether respondent category (Producer/Farmer, Consumer, Other; Trader/Retailer excluded, n = 69) is statistically associated with reported exposure to specific loss causes, deterioration signs, and coping strategies (Table 2). Respondent category was significantly associated with reporting poor storage conditions as a cause of loss ($\chi2 = 14.01$, df = 2, $p < 0.001$), transportation delays as a cause of loss ($\chi2 = 9.36$, df = 2, $p = 0.009$), wilting as a deterioration sign ($\chi2 = 12.22$, df = 2, $p = 0.002$), discoloration as a deterioration sign ($\chi2 = 7.54$, df = 2, $p = 0.023$), and use of refrigeration as a coping strategy ($\chi2 = 9.74$, df = 2, $p = 0.008$). Association with high temperature/humidity as a cause of loss was marginal ($p = 0.086$), and association with use of improved storage techniques as a strategy was not significant ($p = 0.132$).

Table 2. Chi-square tests of association between respondent category and reported post-harvest outcomes (N = 69; * p < 0.05).

Outcome	Producer (n=18)	Consumer (n=30)	Other (n=21)	χ2 (df=2)	p-value
Poor storage (cause)	83.3%	56.7%	23.8%	14.01	<0.001*
High temp/humidity (cause)	77.8%	60.0%	42.9%	4.91	0.086
Transport delays (cause)	66.7%	36.7%	19.0%	9.36	0.009*
Wilting (sign)	88.9%	40.0%	42.9%	12.22	0.002*
Discoloration (sign)	83.3%	70.0%	42.9%	7.54	0.023*
Refrigeration (strategy)	72.2%	66.7%	28.6%	9.74	0.008*
Improved storage (strategy)	66.7%	40.0%	38.1%	4.05	0.132

Given that reporting poor storage conditions as a cause of loss showed the strongest association with respondent category, a binary logistic regression was fitted to test whether respondent category and years of experience jointly predict this outcome, with Consumer as the reference category. The overall model was statistically significant (likelihood-ratio $\chi2 = 15.59$, df = 3, $p = 0.001$; McFadden's pseudo-R2 = 0.16). Relative to consumers, respondents in the Other (processor/handler) category had significantly lower odds of reporting poor storage as a cause of loss (odds ratio [OR] = 0.26, 95% CI: 0.07-0.90, $p = 0.034$), while producers showed higher odds that approached but did not reach conventional significance

(OR = 4.16, 95% CI: 0.97-17.89, p = 0.055), consistent with the descriptive and chi-square results above. Years of experience handling the target vegetables was not a significant independent predictor once respondent category was accounted for (OR = 1.20 per experience category, 95% CI: 0.77-1.87, p = 0.432), suggesting that a respondent's position in the value chain, rather than how long they have been handling these vegetables, is the more important correlate of storage-related loss exposure in this sample.

Discussion

Much of the existing literature on post-harvest losses in African indigenous vegetables documents that heat, poor storage, and transport delays drive losses in general terms (Kader, 2002; FAO, 2011). What this study adds is statistical evidence, within a single value chain and dataset, that exposure to these specific loss mechanisms is not uniform across actor types but is significantly structured by a respondent's position in the value chain: producers, consumers, and processors/handlers differ in ways that are unlikely to be due to chance alone for five of the seven outcomes tested (Table 2), with producers consistently at the highest-risk end of the distribution. This actor-differentiated, statistically tested pattern, rather than the general fact that heat and poor storage cause losses, is the substantive contribution of this study, and directly motivates a targeted rather than uniform approach to intervention design in this value chain.

The finding that temperature/humidity and storage conditions were the leading reported causes of loss overall is consistent with the well-documented sensitivity of leafy indigenous vegetables to water loss and microbial spoilage under tropical ambient conditions, where the absence of cold-chain infrastructure sharply limits shelf life (Kader, 2002; Makule et al., 2022). The narrow 1-2 day freshness window reported by most respondents in this study is broadly consistent with post-harvest quality declines reported for African nightshade under ambient storage in East Africa, where harvesting method, storage duration, and handling practice were shown to materially affect nutritional and physical shelf life (Kirigia et al., 2019), and with reviews of the fresh tomato supply chain in sub-Saharan Africa that similarly identify inadequate storage and delayed transport as leading drivers of loss for that crop (Sibomana et al., 2016).

The chi-square and logistic regression results add statistical weight to the descriptive gradient reported earlier: producers were significantly more likely than consumers to report poor storage conditions and transportation delays as causes of loss, and significantly more likely to report wilting and discoloration as visible deterioration signs, while the processor/handler group was significantly less likely than consumers to report poor storage as a cause. This is consistent with prior evidence that pre-harvest and post-harvest constraints along African leafy vegetable value chains differ meaningfully by actor position in the chain (Kirigia et al., 2017), and with scoping-review evidence that transport and storage infrastructure gaps are among the most frequently reported constraints facing African indigenous vegetable producers specifically (Alulu et al., 2023). That respondent category remained a stronger correlate of

storage-related loss exposure than years of experience in the logistic model suggests that where a respondent sits in the value chain, rather than individual experience or skill, is the more actionable target for intervention design. Producers are the actors with the least control over downstream cold-chain and transport infrastructure, yet they absorb the earliest and statistically most concentrated share of physical loss. Interventions such as low-cost evaporative cooling structures at farm-gate or aggregation points, and improved transport scheduling to reduce delay between harvest and sale, would therefore plausibly deliver the greatest marginal benefit if targeted at producers specifically, rather than distributed uniformly across the value chain, consistent with calls elsewhere for context-appropriate, low-cost cold-storage solutions in sub-Saharan African horticultural value chains (Makule et al., 2022).

The gradient observed between wilting (dominant among producers) and discoloration (dominant among consumers) as the most visible deterioration sign is also informative for designing control points: it suggests that visual quality grading at the point of harvest or aggregation, where wilting is most detectable, could intercept a meaningful share of substandard produce before it enters the retail chain, whereas consumer-facing interventions (e.g., point-of-sale guidance) would need to address discoloration specifically.

The low reported awareness of government or NGO support (27%) and the strong, consistent demand across respondent categories for training and storage infrastructure suggest that current public and non-governmental interventions in this value chain are either limited in reach or poorly communicated to the actors who would benefit from them. This is consistent with a broader pattern noted in food-loss literature for informal, non-export vegetable value chains in sub-Saharan Africa, which tend to receive comparatively less institutional attention and data coverage than export-oriented cash crop chains (Sheahan and Barrett, 2017; Kubitza et al., 2025).

Limitations

Several limitations should be considered when interpreting these findings. First, the sample (N = 71) was recruited through a non-probability, purposive/snowball approach; although researcher-facilitated, in-person engagement was used to improve completion quality and to reach respondents with limited digital literacy (see Study design and sampling), the sampling frame itself remains non-random, which likely biases the sample towards respondents accessible through the researcher's networks. The near-universal reporting of higher education (99%) in this sample is almost certainly not representative of vegetable handlers and traders in these value chains generally, many of whom operate in the informal sector with lower average educational attainment. Findings should therefore be read as indicative of patterns within the achieved sample rather than as representative estimates for the wider population.

Second, the achieved sample size (N = 71), while adequate for descriptive, actor-disaggregated analysis of the kind presented here, is modest, and in particular the Trader/Retailer category (n = 2) is too small to support independent conclusions for that group. Similarly, geographic coverage outside Yaoundé and Buea is thin (n = 1-5 per town), and, as noted in the Study area

section, town of origin is reported for descriptive purposes only and is not used as a basis for statistical comparison between towns. A larger, more geographically balanced follow-up data collection phase, ideally incorporating a probability-based or quota sampling design, is recommended to validate and extend the patterns identified here.

Third, the cross-sectional design captures practices at a single point in time and does not account for seasonal variation in temperature, rainfall, and vegetable supply, which likely influences both post-harvest handling practices and loss rates. Fourth, the study relies on self-reported practices and perceptions rather than direct observation or biochemical measurement of deterioration, which may be subject to recall or social-desirability bias. Finally, while chi-square tests and a logistic regression were used to move beyond pure description above, the non-probability sampling design means these should be interpreted as evidence of association within the achieved sample rather than as population-level causal estimates; the logistic regression in particular, with 69 observations across three predictor categories, has wide confidence intervals for some estimates (e.g., the producer effect, OR = 4.16, 95% CI: 0.97-17.89) and should be treated as an exploratory, hypothesis-generating result pending replication in a larger sample.

Conclusion and Recommendations

This study moves beyond descriptive documentation of post-harvest handling practices for four African indigenous vegetables in Cameroon by statistically testing, and confirming, that exposure to specific loss causes, deterioration signs, and coping strategies is significantly structured by respondent category rather than uniform across the value chain. High temperature/humidity and inadequate storage were the leading reported drivers of loss overall, but chi-square and logistic regression analyses showed that producers are significantly more likely than consumers to report poor storage conditions and transport delays as causes of loss and wilting and discoloration as deterioration signs, while processors/handlers are significantly less exposed to storage-related loss than consumers. Producers should accordingly be prioritised for targeted, low-cost storage and transport interventions, alongside broader investment in post-harvest handling training, which was the single most requested form of support across all respondent categories.

These findings will inform the design of controlled experimental work under the broader PhD research programme on nutritional and biochemical changes in African indigenous vegetables during processing and storage, by identifying which handling stages and actor groups represent the most critical control points for subsequent shelf-life extension trials. Future work should prioritise a larger, more geographically balanced data collection phase capable of supporting multivariate models with adequate power for all respondent categories including traders, and should incorporate a seasonal dimension to data collection to test whether the actor-differentiated patterns identified here hold across cropping seasons.

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