Research Letter

Sustainable dragon fruit wine as an agro-tourism product:
Implications for local tourism systems and community-based commercialization

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Abstract

Sustainable dragon fruit wine production was developed as a community-based agro-tourism product that integrates environmental responsibility, product quality, and local enterprise development. This study developed and evaluated a standardized protocol for sustainable dragon fruit wine production using locally sourced materials and resource-efficient processing methods suitable for small-scale community-based applications. The study aimed to determine the physicochemical quality, sensory acceptability, and potential implications of dragon fruit wine as a value-added agro-processing product with possible relevance to local enterprise development and agro-tourism initiatives. An experimental–developmental research design was employed, integrating controlled fermentation procedures with protocol standardization to improve product consistency, safety, And reproducibility under ambient tropical conditions. Fresh dragon fruits obtained from local growers were processed using reusable fermentation materials and simplified low-input methods to support environmentally responsible production practices. Physicochemical evaluation revealed that the developed dragon fruit wine achieved acceptable quality parameters, including an alcohol content of 8.5 ± 0.7 % (v/v), pH of 3.6 ± 0.2, titratable acidity of 0.45 ± 0.05 %, residual sugar content of 5.2 ' 0.6 %, and satisfactory clarity after aging. These findings indicate that stable and acceptable fruit wine can be produced without reliance on energy-intensive processing systems or synthetic clarifying agents. Sensory evaluation involving 30 purposively selected local participants showed favorable acceptability ratings for color (4.4), aroma (4.2), taste (4.1), mouthfeel (4.0), and overall acceptability (4.3) using a 5-point hedonic scale. Results suggest that the standardized processing protocol was capable of producing a sensory acceptable and environmentally sustainable product using accessible local resources. The findings demonstrate the feasibility of community-based dragon fruit wine production as a sustainable value-added agro-processing initiative that may support local livelihood opportunities and future agro-tourism-related activities. However, the study was limited to preliminary product development, physicochemical analysis, and sensory evaluation. Tourism behavior, commercialization outcomes, and broader consumer responses were not directly investigated and therefore remain potential areas for future research.

Keywords

sustainable dragon fruit wine, agro-tourism product, local tourism systems, community-based commercialization, sensory acceptability

1. Introduction

The growing demand for sustainable food production has increased interest in transforming agricultural resources into value-added products that support environmental sustainability and local livelihoods. Fruit-based fermentation improves the usability and economic value of perishable crops. Salas-Millán (2024) explained that fermentation enhances the stability, sensory qualities, and marketability of fruit-derived products. Gangakhedkar et al. [2025] explained that fermentation technology contributes to food preservation while maintaining the nutritional quality of fruit-based products. Dragon fruit (Hylocereus spp.), despite its nutritional and functional benefits, remains underutilized in many tropical regions. This creates opportunities for sustainable processing methods that reduce post-harvest losses and produce commercially viable products. Fruit wine products may contribute to agro-tourism and food tourism by offering locally produced goods that reflect cultural identity and agricultural practices. Ossowska et al. [2024] emphasized that locally produced beverages can strengthen cultural identity and encourage consumer support for community-based enterprises. However, the present study focuses primarily on product development and sensory evaluation rather than direct tourism assessment.

Sustainable agro-food systems integrate production and processing practices that support ecological balance and local economies [Gibbons et al., 2020]. Çakmakçı et al. [2023] emphasized that sustainability includes efficient production, responsible resource use, and stronger local value chains. Sustainable agro-processing practices reduce environmental impacts through efficient resource utilization and waste minimization. Utilizing locally sourced dragon fruit for wine production promotes resource conservation and minimizes transportation demands. These value-added products may provide future opportunities for agro-tourism through educational and cultural experiences associated with local food production. Gadanakis [2024] added that value-added agricultural products improve the competitiveness of local farming communities by increasing product diversification and market opportunities.

Standardized processing techniques are important in ensuring product consistency, safety, and quality. Traditional fermentation methods often produce inconsistent results that affect consumer acceptance. Controlled fermentation improves microbial activity, product stability, and quality. A standardized food production processes improve product safety, consistency, and consumer confidence in emerging food industries.

Standardization is also important in tourism-related industries where product reliability affects visitor satisfaction and destination reputation.

Sensory quality influences consumer acceptance and purchasing behavior. Taste, aroma, color, and texture are important factors in evaluating locally produced products. Zhu et al. [2023] explained that positive sensory experiences increase consumer satisfaction and repeat consumption. Food and beverage products with favorable sensory qualities may contribute to culinary tourism experiences and local product promotion. However, tourism-related outcomes were not directly measured in this study.

Agro-processing creates income-generating opportunities and strengthens community participation. Fernandez et al. [2025] stated that the economic value of products influences consumer behavior and market practices. Balaji et al. [2025] further emphasized that development depends on productive opportunities and community participation. Mohd et al. [2022] emphasized that small-scale food enterprises contribute significantly to local employment generation and community economic resilience. Small-scale dragon fruit wine production supports local employment, enterprise development, and regional economic growth. Luekveerawattana [2025] noted that agro-tourism activities enhance rural development by integrating agriculture, culture, and tourism experiences within local communities.

Environmental concerns also affect consumer preferences for sustainable and locally produced goods. Wang et al. [2025] explained that environmental values influence consumer decisions. Chavez and Vicente [2024] added that sustainable production practices increase consumer trust and perceived product quality. Sustainability-oriented products may contribute to destination image and responsible tourism practices, although these tourism-related implications remain outside the direct scope of the present investigation. Aransyah et al. [2025] stated that environmentally responsible production practices positively affect destination image and strengthen sustainable tourism development. Cultural and social factors also influence the acceptance of local products. Products ’hat reflect local identity and agricultural heritage carry social and cultural value. Locally produced dragon fruit wine represents community identity, agricultural tradition, and environmental responsibility, strengthening consumer support and cultural appreciation.

Despite increasing interest in sustainable food processing and value-added agricultural products, limited studies have developed standardized dragon fruit wine production protocols within community-based settings. Existing studies largely focus on physicochemical characteristics and sensory properties, while the integration of sustainability-oriented processing practices remains underexplored. Furthermore, although agro-tourism is frequently associated with local food products, empirical tourism-related variables such as visitor behavior, tourist satisfaction, and tourism experiences were not directly examined in this study. Presen’ research focuses specifically on the development, physicochemical evaluation, and sensory acceptability of dragon fruit wine as a value-added product with potential implications for local agro-based enterprise development. The study is limited to product development, physicochemical analysis, and sensory evaluation among locally selected participants. Tourism behavior, tourist perceptions, and large-scale consumer responses were not directly investigated. Therefore, interpretations related to agro-tourism and commercialization are presented only as potential applications rather than empirically verified outcomes

Objectives of the Study

- Develop and standardize a sustainable processing protocol for dragon fruit wine using locally sourced materials and resource-efficient methods.
- Evaluate the physicochemical properties and sensory acceptability of the developed dragon fruit wine in relation to product quality and consumer preference.
- Determine the potential of the standardized dragon fruit wine for community-based commercialization and small-scale value-added product development using locally sourced materials.

2. Literature

2.1 Sustainable fruit processing system

Sustainable fruit processing has gained increasing attention as agricultural sectors seek to reduce waste while improving product value and environmental sustainability [Błaszczyk et al., 2024]. Resource-efficient techniques, including controlled fermentation and reusable materials, help minimize ecological impact, reduce raw material losses, and optimize energy use while maintaining product quality. In fruit-based beverages, optimized fermentation systems enhance product stability, improve microbial control, and reduce spoilage. Likewise, Giacomella et al. [2025] highlights that localized processing decreases reliance on industrial supply chains, lowers transportation-related emissions, and promotes regional self-sufficiency. Within agro-tourism, sustainable processing practices not only improve production efficiency but also support the creation of tourism-ready products that can be integrated into experiential farm activities. Agro-tourism links agricultural production and processing with tourism by offering educational, recreational, and income-generating opportunities for visitors. Similarly, Alviz-Meza et al. [2025] emphasizes that sustainable bioprocessing frameworks combine efficiency and environmental responsibility, particularly in small-scale operations with limited access to advanced technologies.

The integration of traditional knowledge with modern processing techniques is increasingly recognized as essential for sustainable agro-processing innovation. Adapting fermentation practices to local environmental conditions improves feasibility while preserving product authenticity and cultural heritage. Gabriele et al. [2026] describes fermentation as a culturally rooted practice that can be refined for modern applications without compromising sustainability, highlighting its role in

connecting traditional methods with scientific advancements. This integration encourages context-specific solutions that are environmentally suitable and socially acceptable. In addition, Islam and Sanches [2025] stress the importance of resource-efficient food systems that reduce energy consumption and environmental degradation, especially in regions facing resource scarcity. Combining traditional and modern processing methods also enhances agro-tourism experiences, as visitors increasingly seek immersive activities related to local food production, craftsmanship, and sustainable practices. These approaches strengthen agro-industrial resilience in rural communities by maximizing local resources, reducing external inputs, and promoting circular production systems, waste reduction, and efficient use of agricultural by-products.

2.2 Agro-tourism value chain development

According to Semenov et al. [2025] agro-tourism value chain development supports rural growth and economic sustainability by strengthening the links between production, processing, and distribution. This integration enables local producers to participate in value-added activities, increasing profitability, market competitiveness, and income diversification while reducing the vulnerability of smallholder communities. Localized processing also promotes inclusive food systems by integrating small-scale producers into wider markets. Turan et al. [2026] further explains that value chain upgrading allows producers to become active participants in product development and marketing, improving product identity and quality. Innovation within agro-tourism systems also enhances competitiveness and sustainability by helping producers adapt to changing market demands. Agro-tourism connects agriculture and tourism through destination-based products and direct-to-consumer experiences that support rural livelihoods and local economies. In addition, consumer purchasing behavior is influenced by product quality, experiential value, and sustainability narratives [Reamico et al., 2025], highlighting the importance of aligning product development with consumer preferences and sustainability goals.

Value-added products such as fruit wine create opportunities for market differentiation and stronger brand identity. Van Hoang et al. [2025] emphasizes that competitive advantage comes from innovation and the development of distinct products that meet evolving consumer demands. Fruit wine also serves as a tourism commodity that enhances destination attractiveness through tasting activities, direct purchases, and farm-based experiences, strengthening the connection between tourism and agriculture. Increasing consumer awareness further drives demand for locally produced and sustainably processed goods that reflect ethical and environmental values. Furthermore, Tran [2025] highlights that integrated food policies support sustainable value chain development by aligning regulatory frameworks with environmental and economic objectives.

2.3 Consumer acceptance and sensory quality

Consumer acceptance is important in the success of newly developed food products, particularly those produced through alternative processing methods. Sensory attributes such as flavor, aroma, texture, and appearance strongly influence consumer preferences and purchasing decisions [Imtiyaz et al., 2021]. Sensory evaluation helps improve product formulation to meet consumer expectations and ensure product quality. Putrinand Juliana [2025] further states that familiarity and perceived quality increase the likelihood of market acceptance. Products that combine good sensory quality with sustainable processing are more likely to gain consumer support [Hwang et al., 2021; Di Vin et al., 2025], as consumers increasingly value both product quality and environmental responsibility.

Consumer behavior is also influenced by cultural values, environmental awareness, and social norms. Amani [2024] explains that environmentally conscious consumers prefer products associated with ethical and ecological values, highlighting the importance of balancing sensory quality and sustainability. In agro-tourism and culinary tourism, sensory experiences such as taste, aroma, and presentation enhance visitor satisfaction and encourage tourists to purchase, recommend, and revisit destinations, strengthening destination competitiveness and visitor loyalty.

3. Methodology

3.1 Research design

This study employed an experimental–developmental research design to develop, standardize, and evaluate dragon fruit wine using locally sourced materials and sustainable processing practices. The experimental component focused on controlled fermentation and physicochemical testing, while the developmental component emphasized protocol refinement for reproducibility and suitability for small-scale production. The study primarily examined product quality and sensory acceptability through laboratory-based measurements and participant evaluation. Tourism behavior, visitor experience, and broader commercialization outcomes were not directly investigated. Therefore, any references to agro-tourism or commercialization are discussed only as potential applications of the developed product. The methodological approach focused specifically on product development and preliminary acceptability assessment rather than large-scale consumer analysis or tourism system evaluation.

3.2 Participants

The sensory evaluation involved 30 purposively selected adult participants from Zamboanga del Sur, composed of local consumers, food handlers, and individuals familiar with fruit-based beverages. The sample size of 30 participants was considered appropriate for preliminary sensory evaluation and product acceptability assessment commonly applied in exploratory food product development studies. Since the study focused primarily on initial product standardization and sensory feedback rather than large-scale consumer behavior analysis, purposive sampling was utilized to obtain informed evaluations from individuals familiar with fruit-based beverages. However,

the findings should not be generalized to wider consumer populations or commercialization markets without further large-scale investigation.

The study was conducted in a community-based food processing setting where dragon fruit is locally cultivated and readily available. The study did not include tourists, tourism stakeholders, or large-scale consumer groups. Consequently, interpretations related to tourism behavior, market expansion, and commercialization potential should be considered exploratory and limited to the study context. The locale was selected due to its accessibility to fresh raw materials and suitability for small-scale processing. Participation was voluntary, informed consent was secured, and confidentiality of responses was maintained throughout the study. The use of purposive sampling and a relatively small sample size was appropriate for preliminary product evaluation; however, the findings are not intended to represent broader consumer populations or tourism markets.

3.3 Materials and ingredients

Fresh dragon fruits were sourced from local growers to support sustainable procurement and the local agricultural economy. Other ingredients included refined sugar, active dry yeast, and potable water, selected based on safety, availability, and suitability for small-scale production. Processing materials included reusable fermentation containers, glass bottles, sieves, and measuring instruments. Reusable equipment was prioritized to minimize waste and environmental impact. The use of locally accessible and environmentally responsible materials ensured that the standardized protocol could be replicated by community producers, promoting sustainable livelihood and resource efficiency.

3.4 Data gathering procedure

The data collection process followed systematic and ethical procedures. The standardized dragon fruit wine was prepared and subjected to physicochemical testing prior to sensory evaluation. Participants were oriented on the evaluation process and provided informed consent before participation. Sensory evaluation forms were distributed, completed, and collected immediately after assessment. All responses were recorded, organized, and prepared for statistical analysis. Proper documentation ensured transparency, reliability, and replicability of the data collection process. Descriptive statistical methods were used to analyze physicochemical results and sensory evaluation scores. Mean values and frequency distributions were computed to summarize product quality and consumer acceptability. These analyses provided an evidence-based basis for determining the suitability of the standardized dragon fruit wine for sustainable local commercialization. Statistical interpretation supported objective conclusions regarding product quality, consumer preference, and protocol effectiveness

3.5 Data analysis

Descriptive statistics were used to analyze the physicochemical properties and sensory evaluation results of the developed dragon fruit wine. Mean values and standard deviations were computed for physicochemical parameters, while weighted means were used to summarize sensory evaluation scores based on the 5-point hedonic scale. The analysis focused on preliminary product evaluation only. No inferential statistical tests, such as correlation or regression analysis, were conducted due to the exploratory nature of the study and the limited purposive sample of 30 participants. Therefore, the findings are limited to the study participants and should not be generalized to wider consumer or tourism populations.

3.6 Limitations of methodology

This study focused primarily on the development and preliminary evaluation of dragon fruit wine using physicochemical analysis and sensory assessment. The study utilized purposive sampling involving 30 local participants, which limits the generalizability of the findings to broader consumer populations. In addition, tourism-related variables such as visitor experience, tourist satisfaction, travel behavior, and destination attractiveness were not directly measured. The study also relied mainly on descriptive statistical analysis; therefore, relationships among sensory perception, environmental attitudes, and purchasing behavior were not empirically tested through inferential statistical procedures. Consequently, interpretations regarding commercialization potential, sustainable consumption behavior, and agro-tourism implications should be considered preliminary and exploratory in nature.

4. Results

4.1 Development and standardization of the sustainable processing protocol

The study successfully developed and standardized a dragon fruit wine processing protocol suitable for small-scale and community-based production. The finalized procedure, presented in Figure 1, outlines the sequential stages of production including raw material preparation, pulp extraction, formulation, fermentation, clarification, aging, and bottling. The standardized workflow was designed to improve process consistency, product safety, and reproducibility under localized processing conditions. Emphasis was placed on the use of locally sourced dragon fruit and reusable processing materials to support resource efficiency and reduce unnecessary waste during production. Hygienic preparation, controlled ingredient measurements, and standardized fermentation procedures contributed to maintaining product quality and operational consistency. The protocol demonstrates the practical feasibility of implementing environmentally conscious processing practices in rural and small-scale settings using accessible materials and low-input methods.

Fermentation conditions were standardized based on ambient tropical processing environments commonly available in community-based production systems. Primary fermentation was conducted at approximately 27-30 °C for 15 days to facilitate yeast activity and sugar conversion without the need for

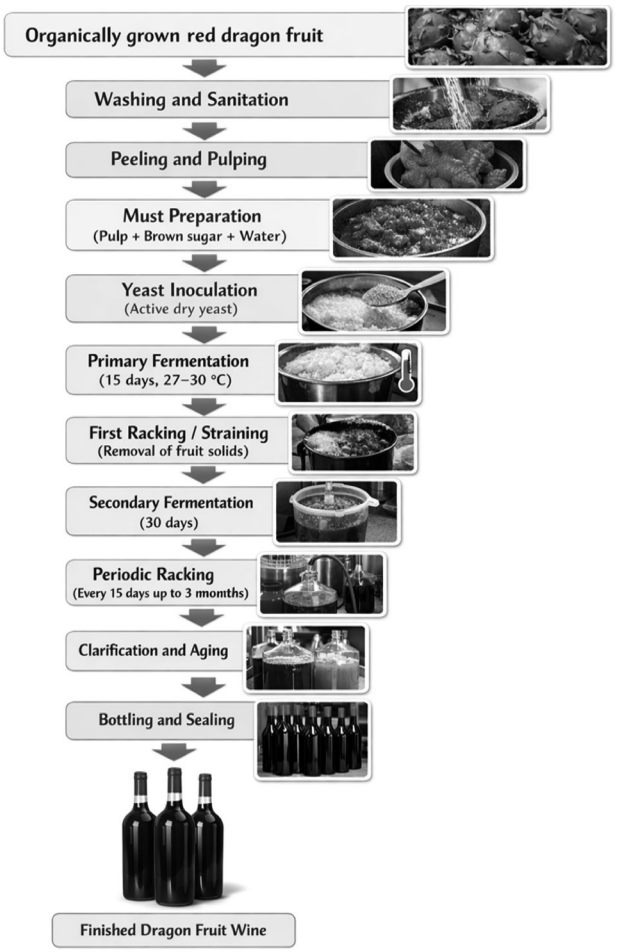

Figure 1: Flowchart of standardized dragon fruit wine processing protocol

energy-intensive temperature control systems. After primary fermentation, solid–liquid separation was performed to improve product clarity and reduce residual particulates. Secondary fermentation and clarification continued for 30 days, with periodic racking every 15 days for up to three months, as illustrated in Figure 2. The stage" clarification and aging process contributed to improved visual clarity, flavor development, and product stability without the use of synthetic clarifying agents. The use of ambient fermentation and minimal chemical intervention supports the applicability of the protocol for sustainable small-scale processing operations.

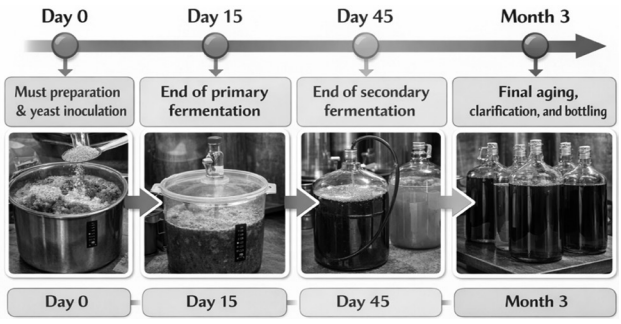

Figure 2: Timeline of fermentation and aging stages for dragon fruit wine production

In addition to physicochemical testing, preliminary sensory evaluation was conducted among 30 purposively selected local participants to assess product acceptability. Sensory attributes including color, aroma, taste, clarity, and overall acceptability were evaluated using descriptive statistical analysis. Participants generally provided favorable ratings for the developed dragon fruit wine, indicating acceptable sensory quality under the standardized processing conditions. Survey responses also reflected positive perceptions regarding the use of locally sourced materials and environmentally responsible production practices. However, the study did not employ inferential statistical procedures such as correlation or regression analysis; therefore, no causal or statistically validated relationships among sensory perception, environmental attitudes, and purchasing intention can be concluded. The findings are limited to preliminary product evaluation within the study sample and should not be generalized to broader consumer or tourism populations.

The standardized processing timeline demonstrated that controlled fermentation and aging procedures can contribute to product consistency, clarity, and sensory acceptability in small-scale dragon fruit wine production. Theyndeveloped protocol provides a replicable framework for localized value-added processing using resource-efficient and environmentally appropriate methods. While the product may have potential applications in community-based enterprise development and agro-tourism activities, tourism behavior, visitor experiences, and commercialization outcomes were not directly investigated in the present study. Therefore, interpretations related to tourism systems and sustainable consumption should be considered exploratory and limited to the context of product development and preliminary sensory assessment.

4.2 Properties of the standardized dragon fruit wine

The physicochemical properties of the standardized dragon fruit wine presented in Table 1 showed values within commonly acceptable ranges for small-scale fruit wine production. The recorded alcohol content of 8.5 ± 0.7 % (v/v) indicates that fermentation proceeded effectively under ambient tropical conditions (27-30 °C). The results demonstrate that acceptable alcohol formation can be achieved without the use of energy-intensive temperature regulation systems, supporting the practical applicability of the standardized protocol for localized and resource-limited processing environments. The use of ambient fermentation conditions may also contribute to reduced energy requirements during production.

The measured pH value of 3.6 ± 0.2 reflects a moderately acidic condition that may help support product stability and microbial control during storage. Similarly, the titratable acidity value of 0.45 ± 0.05 % indicates balanced acid development throughout the fermentation process. These physicochemical characteristics contribute to overall product consistency and are important quality indicators in fruit wine production. The observed clarity of the wine after aging further suggests that the clarification and racking procedures were effective under

Table 1: Estimated physicochemical properties of dragon fruit wine produced using the developed protocol

Parameter	Value (Mean ± *SD*)
Alcohol content (% v/v)	8.5 ± 0.7
pH	3.6 ± 0.2
Titratable acidity (% TA)	0.45 ± 0.05
Residual sugar (%)	5.2 ± 0.6
Color	Pink to light red
Clarity	Clear after aging

the established processing conditions without the use of synthetic clarifying agents.

The residual sugar content of 5.2 and 0.6 % indicates that sugar conversion occurred throughout fermentation while retaining moderate sweetness in the final product. The results suggest that the developed protocol was capable of producing a stable and acceptable fruit wine using locally sourced raw materials and simplified processing methods. However, the present findings are limited to preliminary physicochemical evaluation and descriptive analysis only. Consumer purchasing behavior, long-term shelf stability, broader market acceptability, and tourism-related outcomes were not directly examined in this study. Therefore, interpretations regarding commercialization potential, consumer behavior, and agro-tourism applications should be considered exploratory and limited to the context of small-scale product development and initial quality assessment.

4.3 Sensory acceptability of the standardized dragon fruit wine

The sensory evaluation results presented in Table 2 indicate favorable acceptability of the standardized dragon fruit wine across all assessed attributes. Color received the highest mean score (4.4), suggesting that participants found the appearance visually appealing after the clarification and aging process. Aroma (4.2) and taste (4.1) were also positively evaluated, reflecting acceptable flavor and fermentation characteristics under the standardized processing conditions. Mouthfeel obtained a mean score of 4.0, indicating general satisfaction with the texture and drinking quality of the product. The overall acceptability score of 4.3 suggests that the developed dragon fruit wine was generally well accepted by the participants involved in the preliminary sensory evaluation.

The findings demonstrate that the standardized processing protocol was capable of producing a sensory acceptable fruit wine using locally sourced materials and simplified processing methods. However, the results are limited to descriptive sensory evaluation from 30 purposively selected participants. No inferential statistical analysis was conducted to determine relationships among sensory perception, environmental attitudes, or purchasing intention. Therefore, interpretations related to consumer behavior, commercialization potential, and agro-tourism applications should be considered preliminary and limited to the context of initial product development and acceptability assessment.

Table 2: Sensory evaluation scores (5-point hedonic scale)

Attribute	Mean score
Color	4.4
Aroma	4.2
Taste	4.1
Mouthfeel	4.0
Overall acceptability	4.3

5. Discussion

The development of the standardized dragon fruit wine processing protocol demonstrated that acceptable product quality and process consistency can be achieved under small-scale and ambient processing conditions. The findings support the importance of controlled fermentation and standardized procedures in improving reproducibility using locally accessible methods. This is consistent with Gabriele et al. [2026], who emphasized that controlled fermentation enhances process stability, and Nethavhanani et al. [2026], who highlighted efficiency improvements in small-scale bioprocessing systems. The use of locally sourced materials and reusable equipment also supports resource-efficient processing practices. Fernandez et al. [2025] note that consumers increasingly value products associated with sustainability and authenticity. However, consumer behavior and tourism engagement were not directly examined in the present study.

The physicochemical results indicate that acceptable alcohol content, acidity, residual sugar, and clarity can be achieved without dependence on energy-intensive or chemically intensive processing systems. These findings align with Synani et al. [2024], who discussed environmentally sustainable production systems that minimize external inputs while maintaining product integrity. Similarly, Gaur et al. [2025] emphasized the role of controlled microbial activity in maintaining food quality and safety, while Sheng and Sun [2024] highlighted the environmental benefits of reducing chemical dependency in food processing systems. The absence of synthetic clarifying agents in the present protocol further demonstrates the feasibility of natural clarification methods under localized production conditions. Although food tourism and agro-tourism are often associated with locally produced beverages and tasting experiences, tourism-related outcomes such as visitor satisfaction and destination attractiveness were not directly measured in this study.

The sensory evaluation results further suggest that the developed dragon fruit wine achieved generally favorable acceptability among the participants. These findings support the perspective of Pan et al. [2025] regarding the relationship between product quality and sustainability-oriented production practices. Chuyen and Nga [2025] emphasized the role of value-added processing in strengthening local food systems, while Bogdan et al. [2025] discussed the increasing demand for products associated with environmental and ethical considerations. In addition, Shafi et al. [2021] highlighted the contribution of innovation to product differentiation and market relevance. Matondang and

Ruspitasari [2025] discussed the possible relationship between sensory perception and behavioral intention; however, such relationships were not directly tested in the present study. Since the study utilized descriptive analysis and a limited purposive sample of 30 participants, interpretations related to consumer behavior, commercialization potential, and agro-tourism applications should be considered preliminary and limited to the context of initial product development and sensory evaluation.

6. Conclusion

The study demonstrated that standardized dragon fruit wine production using locally sourced materials and resource-efficient processing methods can achieve acceptable physicochemical quality and sensory acceptability under small-scale ambient conditions. The developed protocol showed consistency in fermentation, acidity, clarity, and overall product acceptability, indicating its feasibility for community-based and value-added agro-processing applications. The findings also suggest that environmentally responsible processing practices can be implemented using simplified and low-input production methods. Sensory evaluation results indicated generally favorable participant responses toward the developed product; however, the study was limited to descriptive analysis involving 30 purposively selected participants. No inferential statistical analysis or direct tourism assessment was conducted. Therefore, interpretations related to consumer behavior, commercialization potential, sustainable consumption, and agro-tourism applications should be considered preliminary and limited to the context of initial product development and sensory evaluation. Nevertheless, the study provides a practical basis for future research on sustainable fruit wine production and its possible applications in community-based enterprise and agro-tourism initiatives.

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