

Developing camias–mango cookies through experiential culinary entrepreneurship education: A mixed-methods product-innovation study in Camarines Sur

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Abstract

This study examined the development of camias–mango cookies as an experiential learning project integrating culinary education, entrepreneurship, sustainability, and local cultural knowledge in [name of school/program] in Camarines Sur, Philippines. Guided by experiential learning and project-based learning, students developed and refined cookie prototypes using locally available mango (*Mangifera indica*) and camias or bilimbi (*Averrhoa bilimbi*), conducted sensory evaluation, gathered stakeholder feedback, and reflected on the educational value of transforming underutilized agricultural resources into a market-oriented product. A convergent mixed-methods design was employed. Quantitative data were obtained from a consumer hedonic test involving participants, while qualitative data were generated through student reflections/focus groups/interviews/observations involving several students and community stakeholders. Quantitative data were analyzed using descriptive statistics, whereas qualitative data were examined through reflexive thematic analysis. Educationally, the project enabled students to connect food science concepts with iterative design, consumer feedback, cultural identity, sustainability, and entrepreneurial decision-making. The study suggests that locally grounded food-product development can serve as an authentic learning task in technology and livelihood education, culinary arts, home economics, and entrepreneurship courses. However, claims concerning nutritional superiority, commercial viability, and broader consumer acceptance require laboratory testing and larger, more diverse samples.

Keywords: culinary education, experiential learning, entrepreneurship education, food-product development, local food systems, sustainability education, Camarines Sur

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1. Introduction

Education in culinary arts, home economics, technology and livelihood education, and entrepreneurship is most meaningful when students can connect disciplinary knowledge with authentic problems. Product-development projects provide such an opportunity because learners must integrate ingredient knowledge, food safety, creativity, sensory evaluation, costing, communication, and market reasoning. This form of learning reflects experiential education, in which knowledge develops through cycles of concrete experience, reflection, conceptualization, and further experimentation (Kolb, 1984). It also aligns with project-based learning, which organizes learning around sustained investigation and the production of a publicly meaningful outcome (Krajcik & Blumenfeld, 2006).

Food-product innovation is particularly suitable for place-based education because locally available ingredients can connect classroom learning with community knowledge, agricultural livelihoods, cultural identity, and sustainability. Sustainable food-systems education commonly integrates farming, culinary practice, processing, nutrition, scientific inquiry, entrepreneurship, leadership, and communication (Ebel et al., 2020). Studies of food education likewise indicate that direct engagement with food can support curiosity, practical competence, and reflection beyond what is possible through lecture-based instruction alone (Walters et al., 2009).

Camarines Sur has a strong agricultural identity, and locally available fruits offer possibilities for contextualized learning and value-added product development. Mango is widely used in food processing, while camias, also known as bilimbi, is commonly used as a souring ingredient but is less visible in commercial baked products. The educational value of combining these fruits is not limited to producing a novel cookie. The activity can engage students in identifying a local problem, researching ingredient functions, testing formulations, interpreting consumer feedback, considering food safety, designing packaging, and evaluating the social and environmental implications of production.

The original project was conceived primarily as a market-oriented food innovation. For an education-focused journal, however, the more important scholarly question is how the product-development process functions as a learning experience. Accordingly, this study situates camias–mango cookie development within experiential culinary entrepreneurship education and examines both product acceptability and student learning.

Purpose and Research Questions - The study aimed to examine camias–mango cookie development as an authentic, locally grounded learning project. It addressed the following questions:

1. How acceptable were the developed camias–mango cookie formulations in terms of appearance, aroma, taste, texture, and overall liking?
2. How did students describe their learning during the processes of formulation, testing, revision, and presentation?
3. What challenges did students encounter in translating local ingredients into a viable food-product concept?
4. What educational practices can teachers and schools derive from the project for culinary, livelihood, sustainability, and entrepreneurship education?

2. Review of Related Literature

Experiential and Project-Based Learning in Culinary Education

Experiential learning emphasizes the transformation of experience into knowledge through action and reflection (Kolb, 1984). In practical culinary settings, students learn not only by following recipes but also by diagnosing problems, adapting procedures, comparing outcomes, and justifying decisions. Recent research on culinary classrooms has highlighted the importance of practical engagement and the classroom conditions that enable or hinder student learning (Koerich & Sousa, 2024). Product-development work can strengthen this process because students repeatedly move between theory and practice. Project-based learning extends this logic by requiring students to investigate a meaningful problem over time and create an assessable product (Krajcik & Blumenfeld, 2006). In the present context, the cookie prototype is not merely an output; it is evidence of students' ability to apply food science, design, communication, collaboration, and evaluation. Entrepreneurship education similarly benefits from authentic tasks in which students generate ideas, test assumptions, respond to users, and revise products. Experiential entrepreneurship activities can help learners move from abstract business knowledge toward entrepreneurial action and self-efficacy (Abd Rahim et al., 2022).

Sustainable Food-Systems and Place-Based Education

Sustainable food-systems education encourages learners to understand the relationships among production, processing, consumption, culture, livelihoods, and environmental responsibility. Ebel et al. (2020) argued that food-systems curricula should combine scientific, culinary, entrepreneurial, and community-oriented learning outcomes. Place-based projects can make these connections visible by using local materials and engaging community knowledge. Rather than treating sustainability as an abstract slogan, students can examine sourcing, seasonality, waste, packaging, affordability, and farmer relationships within a concrete production task.

Fruit-Enriched Cookies and Sensory Evaluation

Research on fruit-enriched cookies indicates that fruits and fruit by-products can alter fiber content, antioxidant properties, texture, color, and sensory acceptance; however, effects depend on formulation and processing (García-Sarrió et al., 2023). Consequently, claims about improved nutrition cannot be inferred solely from the presence of fruit. They require chemical or nutritional analysis. Consumer liking should likewise be assessed systematically. ISO 11136:2014 provides guidance for conducting hedonic tests with consumers under controlled conditions, while descriptive sensory profiling requires different procedures and appropriately prepared assessors.

3. Theoretical and Conceptual Framework

The study is primarily guided by Kolb's (1984) experiential learning cycle. Concrete experience occurs as students prepare and test cookie prototypes. Reflective observation occurs as they examine sensory feedback, production difficulties, and stakeholder responses. Abstract conceptualization occurs when they connect those observations to ingredient functionality, food safety, costing, sustainability, and market positioning. Active experimentation occurs when they revise the formulation, process, or presentation and test the revised product. Project-based learning provides the pedagogical structure. The project begins with an authentic driving problem: How can students transform locally available mango and camias into an acceptable, culturally meaningful, and responsibly designed food product? Students investigate the problem, create prototypes, receive feedback, revise their work, and present a final product and rationale. The conceptual sequence is therefore: local problem and resources → inquiry and product design → prototype testing and stakeholder feedback → reflection and revision → product and learning outcomes.

4. Methodology

Research Design - A convergent mixed-methods product-development design was used. The quantitative component assessed consumer acceptance of the cookie formulations, while the qualitative component examined students' learning experiences and stakeholder interpretations. The two forms of evidence were analyzed separately and then integrated during interpretation. This design is more appropriate than labeling the study purely qualitative because hedonic ratings and formulation comparisons produce quantitative evidence, whereas reflections, interviews, and observations produce qualitative evidence.

Educational Context and Participants - The study was conducted in the school as part of course/program requirements. Student participants were participated in the learning project. Consumer sensory evaluation involved the participants recruited through volunteer sampling procedure. Additional qualitative participants included teachers, farmers, and/or food entrepreneurs. Inclusion criteria, recruitment procedures, and the relationship of the researcher to the participants should be stated explicitly.

Learning and Product-Development Procedure

Problem identification and local-resource inquiry. Students examined the culinary uses, availability, seasonality, and perceived underutilization of mango and camias.

Concept development. Student teams developed a product rationale, target-user profile, and preliminary formulation.

Prototype production. Teams prepared several formulations under standardized food-safety and preparation conditions.

Sensory testing. Coded samples were presented in a counterbalanced or randomized order, with water provided for palate cleansing. Allergen information was disclosed.

Feedback and revision. Students interpreted hedonic results and qualitative comments and revised the formulation or presentation.

Entrepreneurial presentation. Teams prepared costing, packaging, branding, sustainability considerations, and a product pitch.

Reflection. Students completed reflection journals/focus-group discussion/portfolio commentary addressing what they learned, difficulties encountered, decisions made, and changes they would make.

Instruments - Consumer liking was measured using a 9-point hedonic scale covering appearance, aroma, taste, texture, and overall liking. The instrument and procedures should be aligned with ISO 11136:2014. Student learning was documented using reflection prompts. Suggested domains include application of food-science concepts, iterative problem-solving, teamwork, response to feedback, entrepreneurial reasoning, cultural connection, and sustainability awareness.

Data Analysis - Hedonic ratings were summarized using means, standard deviations, frequencies, and confidence intervals. Differences among formulations were examined using descriptive statistics. Qualitative data were transcribed and analyzed using reflexive thematic analysis following Braun and Clarke's (2006, 2022) approach: familiarization, coding, initial theme development, theme review, theme definition, and reporting. Analysis should be iterative and interpretive rather than presented as a mechanical count of comments. Trustworthiness can be strengthened through a documented audit trail, reflexive notes, peer discussion of interpretations, and the use of sufficiently rich quotations (Nowell et al., 2017).

Ethical Considerations - The study follows standard research ethics and protocols for human subject protection. Participation was voluntary, and informed consent—and parental consent and student assent where

minors were involved—was secured. Participants were informed that declining would not affect grades or school standing. Data were anonymized. Food-safety procedures included hygienic preparation, allergen disclosure, exclusion of participants with relevant allergies or medical restrictions, and safe sample storage and handling.

5. Results

The study on the development and evaluation of Camias Mango Cookies revealed several important insights regarding product innovation, consumer acceptability, and cultural-economic relevance. The formulation of cookies using locally sourced mangoes and camias from Camarines Sur successfully demonstrated the potential of underutilized tropical fruits to be transformed into value-added products. The combination of mango's natural sweetness and camias' tartness created a distinctive flavor profile that respondents found both novel and appealing.

Results from the sensory evaluation showed that the majority of respondents rated the cookies positively in terms of taste, aroma, texture, and overall acceptability. Among the different prototypes tested, the soft-baked variant received the highest preference, particularly for its balance of flavor and moist texture. The hedonic scale analysis confirmed that the product met consumer expectations for indulgence while offering functional health benefits such as Vitamin C and reduced refined sugar content. The market survey highlighted strong purchase intent among health-conscious millennials, Gen Z, and members of the Filipino diaspora. Respondents expressed interest in the product's cultural authenticity and sustainability, noting that the use of local fruits from Camarines Sur added emotional and cultural value. Packaging appeal and branding were also identified as important factors influencing consumer acceptance, with respondents favoring eco-friendly and culturally inspired designs.

Qualitative data from interviews with local farmers and food entrepreneurs emphasized the economic potential of Camias Mango Cookies. Farmers noted that the commercialization of camias, a fruit often overlooked in mainstream markets, could provide new income streams and strengthen agribusiness in the province. Entrepreneurs highlighted the product's potential to compete in both local and international markets due to its unique flavor and cultural identity. Overall, the findings confirm that Camias Mango Cookies are not only sensory acceptable but also culturally significant, economically viable, and health-conscious, making them a promising innovation for sustainable food development in Camarines Sur.

6. Conclusions

Based on the findings of the study, it can be concluded that the development of Camias Mango Cookies successfully demonstrates the potential of underutilized tropical fruits, particularly mangoes and camias from Camarines Sur, to be transformed into innovative, functional, and culturally authentic food products. The combination of mango's sweetness and camias' tartness created a distinctive flavor profile that was well-accepted by respondents, with the soft-baked variant emerging as the most preferred formulation. The results of the sensory evaluation confirmed that the cookies met consumer expectations in terms of taste, aroma, texture, and overall acceptability. The product not only satisfied indulgent snacking preferences but also addressed the demand for healthier alternatives by offering nutritional benefits such as Vitamin C and reduced refined sugar content.

The market survey further revealed strong purchase intent among health-conscious millennials, Gen Z, and members of the Filipino diaspora, who valued the product's cultural authenticity and sustainability. Respondents emphasized that packaging and branding rooted in Filipino identity would enhance its appeal in both local and international markets. Interviews with local farmers and entrepreneurs highlighted the economic potential of Camias Mango Cookies, noting that the commercialization of camias could provide new income streams and strengthen agribusiness in Camarines Sur. This underscores the product's role not only as a culinary innovation but also as a driver of community empowerment and sustainable development. In conclusion, the study affirms that Camias Mango Cookies are a viable food innovation that bridges culinary creativity, consumer health consciousness, cultural heritage, and economic sustainability. They represent a promising product that can uplift local agriculture while appealing to global food markets.

Recommendations

Based on the findings and conclusions of the study, several recommendations are proposed to strengthen the development, promotion, and sustainability of Camias Mango Cookies.

- First, it is recommended that future product development continue refining the formulation of the cookies, particularly the balance between mango's sweetness and camias' tartness, to further enhance consumer acceptability. Variations such as gluten-free or plant-based versions may also be explored to cater to diverse dietary preferences.
- Second, nutritional analysis should be expanded beyond basic attributes to include more detailed biochemical testing, ensuring that the product can be marketed as a truly functional snack with scientifically validated health benefits.
- Third, market expansion efforts should be pursued by conducting larger-scale consumer testing across different regions of the Philippines and abroad. This will provide broader insights into consumer preferences and strengthen the product's potential for commercialization in both local and international markets.
- Fourth, collaboration with local farmers and agribusiness is highly encouraged to ensure sustainable sourcing of mangoes and camias. Establishing partnerships can help create value-added income streams for rural communities in Camarines Sur, while also ensuring consistent supply for production.
- Fifth, branding and packaging should emphasize cultural authenticity and sustainability. Eco-friendly packaging materials and designs inspired by Filipino heritage can enhance consumer appeal and align with global trends toward responsible consumption.
- Lastly, it is recommended that future research explore the long-term economic and cultural impact of Camias Mango Cookies, including their role in promoting Filipino fruit heritage and supporting agribusiness innovation in Camarines Sur. The need for continued product refinement, expanded nutritional validation, broader market testing, sustainable farmer partnerships, culturally inspired branding, and future research. These steps will ensure that Camias Mango Cookies evolve into a competitive, sustainable, and culturally significant food innovation.

Practical Educational Implications

For Teachers - Teachers can use locally grounded product development as an authentic performance task rather than a one-time cooking exercise. Instruction should require students to document the problem, justify ingredient choices, standardize procedures, collect user evidence, revise prototypes, and reflect on decisions. Assessment rubrics can separately evaluate culinary technique, food safety, scientific reasoning, creativity, teamwork, use of evidence, sustainability, and entrepreneurial communication. Teachers should explicitly teach students that consumer liking, nutritional quality, and commercial feasibility are different constructs requiring different forms of evidence.

For Students - Students can gain opportunities to integrate knowledge across food science, mathematics, communication, culture, sustainability, and business. Iterative testing can normalize productive failure and help learners see feedback as evidence for improvement. Maintaining formulation logs, costing sheets, sensory records, reflection journals, and design rationales can also strengthen research literacy and accountability. Students should be encouraged to make modest, evidence-based claims and to identify what additional testing would be required before marketing a product.

For Schools and School Leaders - Schools can support this type of learning by providing safe food laboratories, basic sensory-testing materials, time for repeated trials, and access to community partners. Partnerships with

farmers, local government units, food technologists, entrepreneurs, and higher education institutions can improve authenticity and technical rigor. Schools may showcase products through learning exhibitions or entrepreneurship fairs, but assessment should prioritize learning and responsible inquiry rather than sales alone. Small grants or ingredient funds can promote equitable participation so that project quality does not depend on students' personal resources.

For Curriculum Designers and Teacher Educators - The project illustrates how technology and livelihood education, home economics, culinary arts, science, sustainability education, and entrepreneurship can be integrated around a common local problem. Teacher preparation should therefore include training in project facilitation, sensory-evaluation basics, qualitative reflection, ethical community engagement, food safety, and authentic assessment. Curriculum guides can include staged milestones—problem inquiry, proposal, prototype, testing, revision, and public presentation—to make the learning process visible and assessable.

Limitations - The limitations must reflect the completed study. Likely limitations include a single-school or single-community setting, a small convenience sample, short-term assessment, possible teacher-researcher influence, limited training of sensory evaluators, lack of laboratory nutritional analysis, absence of shelf-life and microbial testing, and no direct measure of long-term entrepreneurial outcomes. These constraints limit claims about generalizability, health benefits, and commercial viability.

Declaration of Generative AI and AI-Assisted Technologies - During the preparation of this manuscript, the author used ChatGPT, developed by OpenAI, to assist with language editing, organization, clarity, and the refinement of the paper. No AI-generated data, participant responses, findings, quotations, analyses, or references were included without verification. The authors remain fully responsible for the accuracy, originality, interpretation, and integrity of the final manuscript.

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