ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Acceptability of Potato (*Solanum tuberosum*) as Flour Ingredient for Gluten-Free Blondie

Jesica O. Boter and Melissa B. Angeles
Graduate Studies, Naga College Foundation, Inc., Naga City, Camarines Sur, Philippines
jboter@gbox.ncf.edu.ph; mangeles@ncf.edu.ph

Date Submitted:
September 04, 2026

Date Accepted:
October 17, 2026

Date Published:
November 16, 2026

DOI:
10.5281/zenodo.24285737

ABSTRACT

Gluten-free baked products are in growing demand, yet many rely on refined starches and imported flours. This study determined the acceptability of potato (*Solanum tuberosum*) flour as the main flour ingredient in gluten-free blondies in Barangay Bani, Tinambac, Camarines Sur, Philippines. Using descriptive, experimental, and research and development methods guided by the Stage-Gate model, the researcher processed locally grown potatoes into flour through drying and pulverization and produced three blondie formulations containing one cup (Formulation 1), one-half cup (Formulation 2), and one-quarter cup (Formulation 3) of potato flour, with all other ingredients held constant. Thirty purposively selected evaluators, ten students, ten teachers, and ten parents, rated the formulations on aroma, texture, taste, color, and appearance using a four-point acceptability scale and rated the product's economic value. Data were analyzed using weighted mean, one-way analysis of variance, and cost analysis, and shelf life was determined through physical observation over 21 days. All three formulations were Highly Acceptable, with Formulation 3 obtaining the highest overall weighted mean (3.09), followed by Formulation 2 (2.95) and Formulation 1 (2.94). Formulation 2 was preferred in aroma and taste, while Formulation 3 was preferred in texture and appearance. The differences among formulations were not significant, $F(2, 87) = 1.233$, $p = .297$. The blondies retained their sensory qualities for about 14 days under ambient storage, after which signs of spoilage appeared. Economic value was rated Very High (3.57), and one batch of 20 pieces cost Php 40.00 to produce and yielded a projected profit of Php 80.00. The study concludes that potato flour is a viable, locally available ingredient for acceptable gluten-free blondies and an economically promising product for small-scale producers, while shelf-life extension and further product refinement are recommended.

Keywords: *potato flour, gluten-free, blondie, sensory acceptability, shelf life, economic value*

INTRODUCTION

People are increasingly searching for healthier and more sustainable food alternatives. Advances in technology and social media have made information on nutrition more accessible, encouraging consumers to prioritize their health and make informed choices about the food they eat. Sweet and pastry products remain among the most popular foods, yet not everyone can enjoy them: individuals with celiac disease, non-celiac gluten sensitivity, or wheat allergy must follow a gluten-free diet, which excludes wheat flour, the key ingredient of most breads, cakes, cookies, and bars (El Khoury et al., 2018). For these consumers, safe and appealing alternatives to conventional baked goods remain limited.

The blondie is one such popular pastry. Similar to a brownie but made without cocoa, it is typically prepared from butter, brown sugar, eggs, vanilla, and all-purpose flour, which gives it its characteristic chewy texture and caramel-like flavor. Because it depends on wheat flour, the conventional blondie is unsuitable for

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International Journal
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people on a gluten-free diet. Potatoes offer a promising substitute. They are naturally gluten-free, widely cultivated, and nutritionally valuable, providing carbohydrates, potassium, vitamin C, and vitamin B6 (Agarwal & Fulgoni, 2021; Tian et al., 2016). Developing gluten-free products from potato flour also supports Sustainable Development Goal 3 on good health and well-being by giving individuals with gluten-related disorders safe and nutritious food options (United Nations, 2015).

Research worldwide has increasingly focused on alternative flours from root crops and other underutilized materials for healthier and gluten-free baked goods. Studies have examined how variety and drying method affect the properties of root-crop flours (Pereira et al., 2025), how gluten-free formulations differ from conventional products (Belorio & Gómez, 2020), and how composite flours can improve the nutritional value of bread (Ewunetu et al., 2023). In the Bicol Region, a growing body of product development studies has transformed local crops into value-added baked goods, including sweet potato and malunggay cupcakes (Casiro, 2025), lesser yam flour food bars (Señar, 2025), banana blossom cookies (Borja, 2025), and avocado seed keto cookies (Arce, 2024).

Despite this interest, no study has examined potato flour as the principal flour ingredient in gluten-free blondies, and little is known about the acceptability, shelf life, and economic value of such a product in a Philippine rural community. This study therefore determined the acceptability of potato flour as an ingredient in baking gluten-free blondies in Barangay Bani, Tinambac, Camarines Sur. Specifically, it aimed to identify the processes and procedures involved in producing potato gluten-free blondies; to determine the best formulation of potato flour; to determine whether significant differences exist among three formulations; to evaluate the level of acceptability of the blondies in terms of aroma, texture, taste, color, and appearance, as well as their shelf life; and to determine the economic value of using potato flour in baking gluten-free blondies. The findings are expected to benefit individuals with gluten sensitivities, small food businesses, home economics educators and students, nutritionists, and potato farmers and agricultural agencies.

Literature Review

Gluten-Related Disorders and Gluten-Free Baked Products

Gluten is a group of storage proteins found in wheat, barley, and rye that gives dough its elasticity and helps baked goods hold their shape. A strict gluten-free diet is the only effective treatment for celiac disease and is also followed by people with non-celiac gluten sensitivity and wheat allergy (El Khoury et al., 2018). Because gluten provides structure, removing it creates technological challenges, and many commercial gluten-free products rely on refined starches, added fats, and sugars to achieve acceptable texture, which can lower their nutritional quality (El Khoury et al., 2018).

Comparisons of gluten-free and gluten-containing baked goods illustrate these trade-offs. Belorio and Gómez (2020) found that gluten-free muffins differ from conventional muffins in their ingredients and nutritional profile, often containing more fat and less protein and fiber. Djordjević et al. (2024) noted that gluten-free breads are frequently low in bioactive compounds and that incorporating plant-based ingredients can improve their nutritional and sensory properties. Safety is another concern: Wieser et al. (2021) emphasized that gluten-free products are vulnerable to cross-contamination during processing, making careful sourcing and preparation essential.

Potato as a Gluten-Free Raw Material

Potatoes are a global staple that is naturally free of gluten. Agarwal and Fulgoni (2021) found that potato intake among adolescents was associated with higher diet quality and improved intake of nutrients such as potassium, fiber, and vitamin C. Tian et al. (2016) reviewed the health benefits of potatoes and showed that domestic cooking and processing methods affect their nutritional and bioactive components, underscoring the importance of appropriate processing when potatoes are converted into ingredients.

Converting tubers into flour extends their storage life and makes them easier to use in baking. The functional properties of the resulting flour depend on the drying method and the raw material: Pereira et al. (2025)

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found that hot-air drying and freeze-drying produced sweet potato flours with different water absorption, oil absorption, swelling, and foaming properties. These findings indicate that controlled drying and pulverization are critical when producing potato flour for baked products.

Local Crops in Value-Added Baked Products

Composite and alternative flours from local crops have been successfully used to improve the nutritional value of baked goods. Ewunetu et al. (2023) showed that bread made from wheat, banana, and carrot composite flour had enhanced nutritional value while remaining acceptable to consumers. Locally, graduate studies in home economics have transformed indigenous crops into acceptable products, including siling labuyo-flavored cakes and cookies (Angeles, 2018), coconut cupcakes (Beatriz, 2019), squash-based recipes (Castro, 2019), avocado seed keto cookies (Arce, 2024), banana blossom cookies (Borja, 2025), sweet potato and malunggay cupcakes (Casiro, 2025), and lesser yam flour food bars (Señar, 2025).

Across these studies, a common thread is the use of systematic formulation and sensory evaluation to identify acceptable ratios of alternative ingredients and to establish their economic potential for households and small enterprises. However, these studies did not use potato flour as the primary flour in a gluten-free dessert bar, nor did they evaluate a potato-based product's shelf life together with its sensory and economic value.

Theoretical Framework

This study was anchored on three theories. The Diffusion of Innovations Theory explains how new ideas, practices, and products spread through a social system over time and identifies the attributes of an innovation that influence its adoption, including relative advantage, compatibility, complexity, and trialability (LaMorte, 2022; Rogers, 2003). In this study, the potato gluten-free blondie is the innovation: its sensory quality, gluten-free nature, local availability, and affordability determine whether consumers and producers are likely to adopt it.

Bruner's Discovery Learning Theory holds that learners construct knowledge by actively exploring, manipulating materials, and observing outcomes (Bruner, 1961). This theory guided the researcher's experimentation in transforming raw potatoes into flour and in testing different proportions of potato flour to discover the most acceptable formulation. The Theory of New Product Development views a new product as the result of a creative idea that satisfies consumer needs and emphasizes a structured progression from concept to market (Gurbuz, 2018). The Stage-Gate model operationalizes this progression by dividing development into sequential stages separated by decision gates at which feasibility and quality are verified before the project proceeds (Cooper, 1990).

Research Gap and Conceptual Framework

Although studies have documented the nutritional value of potatoes and the use of alternative flours in baked goods, there is limited evidence on potato flour as the principal ingredient in gluten-free blondies, on the acceptability of such a product to different consumer groups in a rural Philippine community, and on its shelf life and economic value. This study addressed these gaps.

Figure 1 presents the conceptual framework, which follows the Input–Process–Output model integrated with the Stage-Gate new product development process. The inputs are the raw potatoes, the other ingredients, and the utensils and equipment. The process follows the Stage-Gate sequence from discovery and scoping through building the business case, development, testing and validation, launching, and post-launch review. The outputs are the potato gluten-free blondie, its acceptability, shelf life, and economic value, and the comparison of the formulations, with feedback from the results informing further product refinement.

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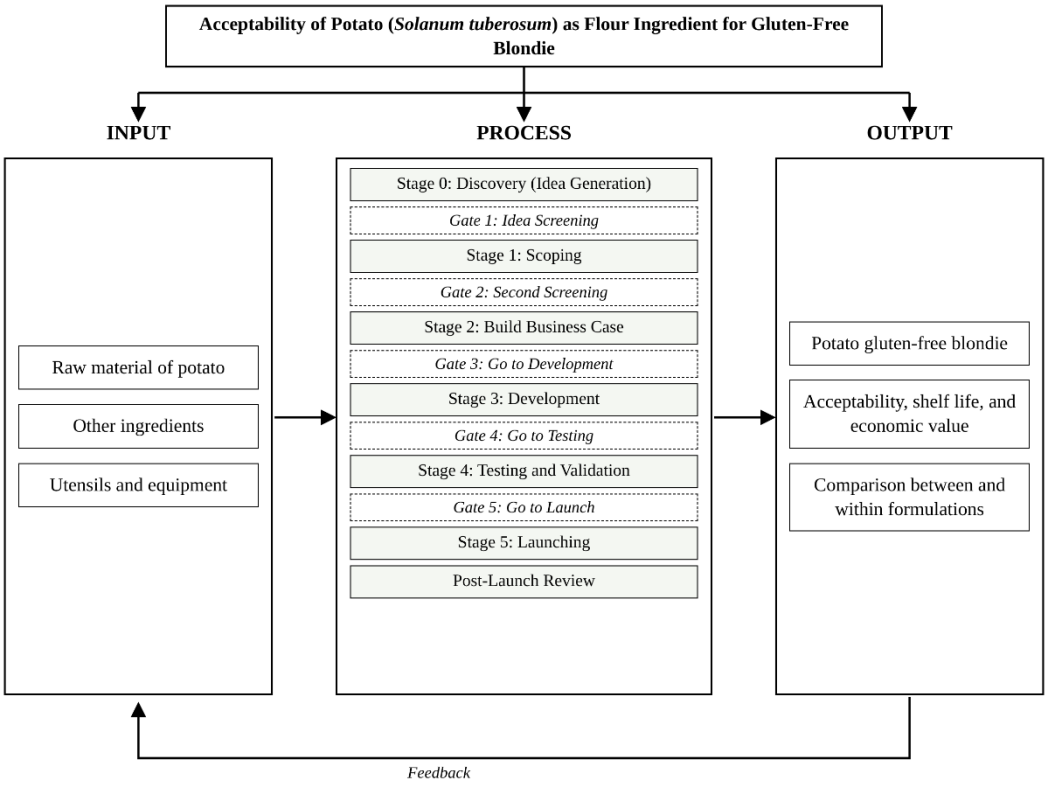


Figure 1. *Conceptual Framework of the Study*

METHODS

Research Design

The study employed descriptive, experimental, and research and development (R&D) methods. The experimental method was used to prepare three formulations of potato gluten-free blondies that differed only in the amount of potato flour, with all other ingredients and procedures held constant. The descriptive method was used to assess the acceptability of the blondies in terms of aroma, texture, taste, color, and appearance, their shelf life, and their economic value. R&D, guided by the Stage-Gate model (Cooper, 1990), structured the development of the product from idea generation through testing and evaluation.

Research Locale

The study was conducted in Barangay Bani, Tinambac, Camarines Sur, Philippines. The potatoes used were the common, locally available variety harvested directly from farms in Barangay Bani and adjacent municipalities. Other potato cultivars and genetically modified varieties were excluded to ensure consistency in raw material quality.

Participants and Sampling Technique

Thirty evaluators were selected through purposive sampling: ten students, ten teachers, and ten parents from the same school community in Barangay Bani, where the students studied, the teachers taught, and the parents' children attended school. No specific age, sex, or other characteristics were required. Each evaluator assessed all three formulations of the potato gluten-free blondie.

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Research Instrument

A modified sensory evaluation checklist and rating sheet, constructed in English and Bikol, was used to determine the level of acceptability of the blondies in terms of aroma, texture, taste, color, and appearance, with space for comments and suggestions. Each attribute was rated on a four-point scale with descriptive anchors (for example, for aroma, from "nothing noticeable" to "smells exceptionally good"), and mean scores were interpreted as 3.26–4.00, Very Highly Acceptable; 2.51–3.25, Highly Acceptable; 1.76–2.50, Moderately Acceptable; and 1.00–1.75, Less Acceptable. A five-item rating scale assessed the economic value of the product, interpreted from Very Low Viability to Very High Viability using the same score ranges. Because the instruments were modified, their content was reviewed by the panel members, but no formal reliability testing was conducted.

Data Gathering Procedure

The study proceeded in three phases. In the preliminary phase, the research problem was conceptualized, approval and permission to conduct the study were secured, the evaluators were identified, and raw potatoes and other ingredients were collected. In the creative phase, the potatoes were washed, peeled, sliced, and dried for about three to five hours under the sun or in a dehydrator, then pulverized into flour. Three formulations were prepared, each containing one cup of butter, one-half cup of brown sugar, one whole egg, one-half teaspoon of vanilla, and either one cup (Formulation 1), one-half cup (Formulation 2), or one-quarter cup (Formulation 3) of potato flour. For each formulation, the wet and dry ingredients were combined, spread in a lined pan, and baked at 350°F (175°C) for 25 to 30 minutes, then cooled before slicing and packaging. In the evaluation phase, the evaluators rated the three formulations using the rating sheet, and the questionnaires were retrieved for analysis. Shelf life was determined by observing the blondies' texture, aroma, color, and signs of spoilage under ambient storage over 21 days.

Data Analysis

The weighted mean was used to determine the level of acceptability of each formulation for each attribute and respondent group and to determine the economic value of the product. One-way analysis of variance (ANOVA) was used to determine whether significant differences existed in the overall acceptability of the three formulations at the .05 level of significance, with Tukey's Honestly Significant Difference test planned as a post hoc test if the ANOVA was significant. Production cost, sales, and profit for one batch of the best formulation were computed using prevailing local market prices.

Ethical Consideration

Informed consent was obtained from all evaluators after they were briefed on the purpose and procedures of the study, and participation was voluntary. Evaluators were assigned code identifiers to protect their identities, and results were reported only in aggregate form in compliance with Philippine data privacy standards. The products were prepared hygienically using safe, locally sourced ingredients to minimize health risks, and communication was conducted in the local language to respect the community's culture. The study observed the principles of beneficence, non-maleficence, and social value consistent with the Philippine National Health Research System Act of 2013 (Republic Act No. 10532, 2013). The researcher acknowledged the use of artificial intelligence tools in the research process and took responsibility for verifying all AI-assisted outputs.

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RESULTS AND DISCUSSION

Processes and Procedures in Producing Potato Gluten-Free Blondies

The development of the potato gluten-free blondies followed the Stage-Gate process. In Stage 0 (Discovery), the need for affordable, nutritious, gluten-free alternatives was identified and potato was recognized as a viable raw material, and Gate 1 confirmed the feasibility and relevance of the idea. Stage 1 (Scoping) gathered information on potato properties, processing techniques, and product requirements, which Gate 2 validated. Stage 2 (Build Business Case) defined the formulations, production methods, and preliminary cost estimates, after which Gate 3 approved development. Stage 3 (Development) covered the conversion of potatoes into flour through drying and pulverization and the preparation of the three formulations, and Gate 4 checked that the samples were consistent and safe before evaluation. Stage 4 (Testing and Validation) involved sensory evaluation, shelf-life observation, and economic analysis, and Gate 5 determined whether the product met acceptable standards. Stage 5 (Launch) finalized the best formulation, and the post-launch review synthesized the findings into conclusions and recommendations.

Table 1 presents the three formulations, which differed only in the amount of potato flour, making potato flour the sole manipulated variable. This structured, gate-controlled process made the development systematic and replicable and ensured that the product was verified for feasibility and quality at every stage, consistent with the Stage-Gate model (Cooper, 1990) and the Theory of New Product Development (Gurbuz, 2018). The hands-on processing of potatoes into flour and the testing of different ratios also reflect Bruner's (1961) view that knowledge is constructed through exploration and experimentation. Similar systematic approaches have been used to transform local crops into acceptable baked products (Borja, 2025; Casiro, 2025; Señar, 2025).

Table 1. *Formulations of Potato Gluten-Free Blondies*

Ingredient	Formulation 1	Formulation 2	Formulation 3
Potato flour	1 cup	½ cup	¼ cup
Salted butter	1 cup	1 cup	1 cup
Brown sugar	½ cup	½ cup	½ cup
Whole egg	1 piece	1 piece	1 piece
Vanilla	½ tsp	½ tsp	½ tsp

Note. All formulations were baked at 350°F (175°C) for 25–30 minutes.

Best Formulation of Potato Flour for Gluten-Free Blondies

Table 2 summarizes the overall acceptability of the three formulations across all sensory attributes. All formulations were Highly Acceptable when the responses of the three groups were combined. Formulation 3, with one-quarter cup of potato flour, obtained the highest combined weighted mean (3.09), followed by Formulation 2 (2.95) and Formulation 1 (2.94). Students rated Formulation 3 Very Highly Acceptable (3.28), teachers rated Formulation 2 highest (3.22), and parents rated Formulation 3 highest (2.90), although all of their ratings fell within the Highly Acceptable range.

Table 2. *Overall Acceptability of the Three Formulations by Respondent Group*

Respondents	F1 WM	Int	F2 WM	Int	F3 WM	Int
Students	3.08	HA	2.88	HA	3.28	VHA
Teachers	2.88	HA	3.22	HA	3.10	HA
Parents	2.86	HA	2.74	HA	2.90	HA
Combined	2.94	HA	2.95	HA	3.09	HA
Rank	3		2		1	

Note. F = Formulation; WM = weighted mean across aroma, texture, taste, color, and appearance. 3.26–4.00 = Very Highly Acceptable (VHA); 2.51–3.25 = Highly Acceptable (HA); 1.76–2.50 = Moderately Acceptable (MA); 1.00–1.75 = Less Acceptable (LA).

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These results indicate that potato flour was a suitable substitute for wheat flour in gluten-free blondies, since all formulations met the Highly Acceptable standard. Formulation 3 emerged as the best formulation, suggesting that a lower proportion of potato flour relative to the other ingredients produced the most balanced product. The narrow range of combined scores (2.94 to 3.09) also suggests flexibility, allowing producers to adjust the formulation according to cost or availability without a large loss in acceptability. Comparable studies have found that local crops, when systematically formulated, can replace conventional ingredients in baked goods while maintaining desirable sensory qualities (Arce, 2024; Borja, 2025).

Differences Among the Three Formulations

Table 3 presents the results of the one-way ANOVA on the overall acceptability of the three formulations. The difference among formulations was not significant, $F(2, 87) = 1.233$, $p = .297$; thus, the null hypothesis was accepted. Because the ANOVA was not significant, no post hoc test was conducted.

Table 3. *Analysis of Variance of the Overall Acceptability of the Three Formulations*

Source of variation	SS	df	MS	*F*	*p*	Interpretation
Between formulations	0.451	2	0.225	1.233	.297	Not significant
Within formulations	15.905	87	0.183			
Total	16.356	89				

Note. Significant at $p < .05$. No post hoc test was conducted because the ANOVA was not significant.

The variation in ratings among formulations was comparable to the natural variation in individual perception within each formulation. Although Formulation 3 ranked highest descriptively, its advantage was not large enough to be statistically distinct. This indicates that potato flour performed consistently across the tested proportions and that producers may choose among the formulations according to raw material cost, availability, or nutritional goals without a significant loss in acceptability. From the perspective of the Diffusion of Innovations Theory, consistent quality across formulations lowers the perceived risk of adopting the product for both producers and consumers (Rogers, 2003).

Level of Acceptability in Terms of Sensory Attributes

Table 4 presents the acceptability of the three formulations by sensory attribute and respondent group. In terms of aroma, Formulation 2 was rated Very Highly Acceptable by all three groups and obtained the highest combined weighted mean (3.43), while Formulations 1 (2.87) and 3 (2.80) were Highly Acceptable. The consistency of this preference across students, teachers, and parents suggests that the middle proportion of potato flour produced the most appealing fragrance, while none of the formulations produced an unpleasant scent.

Table 4. *Acceptability of the Three Formulations by Sensory Attribute and Respondent Group*

Attribute and respondents	F1 WM	Int	F2 WM	Int	F3 WM	Int
Aroma						
Students	2.80	HA	3.40	VHA	3.10	HA
Teachers	2.90	HA	3.50	VHA	2.70	HA
Parents	2.90	HA	3.40	VHA	2.60	HA
Combined	2.87	HA	3.43	VHA	2.80	HA
Texture						
Students	2.90	HA	2.20	MA	3.70	VHA
Teachers	2.40	MA	3.20	HA	3.10	HA
Parents	2.60	HA	2.50	MA	3.40	VHA
Combined	2.63	HA	2.63	HA	3.40	VHA
Taste						
Students	3.10	HA	3.60	VHA	3.50	VHA
Teachers	3.20	HA	3.90	VHA	2.70	HA

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Attribute and respondents	F1 WM	Int	F2 WM	Int	F3 WM	Int
Parents	3.30	VHA	3.00	HA	2.20	MA
Combined	3.20	HA	3.50	VHA	2.80	HA
Color						
Students	2.90	HA	2.30	MA	2.30	MA
Teachers	3.10	HA	2.30	MA	3.50	VHA
Parents	2.70	HA	2.00	MA	2.90	HA
Combined	2.90	HA	2.20	MA	2.90	HA
Appearance						
Students	3.70	VHA	2.90	HA	3.80	VHA
Teachers	2.80	HA	3.20	HA	3.50	VHA
Parents	2.80	HA	2.80	HA	3.40	VHA
Combined	3.10	HA	2.97	HA	3.57	VHA

Note. F = Formulation; WM = weighted mean. 3.26–4.00 = Very Highly Acceptable (VHA); 2.51–3.25 = Highly Acceptable (HA); 1.76–2.50 = Moderately Acceptable (MA); 1.00–1.75 = Less Acceptable (LA).

In terms of texture, preferences varied by group. Students and parents rated Formulation 3 Very Highly Acceptable (3.70 and 3.40), whereas teachers rated Formulation 2 highest (3.20). Formulation 2 received Moderately Acceptable ratings from students (2.20) and parents (2.50), and Formulation 1 a Moderately Acceptable rating from teachers (2.40). Combining the three groups, Formulation 3 obtained the highest texture rating (3.40, Very Highly Acceptable), while Formulations 1 and 2 were each Highly Acceptable (2.63). The variation in group ratings reflects differing expectations for a softer and moister or a firmer and denser crumb, consistent with evidence that the functional properties of root-crop flours, such as water absorption and swelling, vary with processing (Pereira et al., 2025).

In terms of taste, Formulation 2 obtained the highest combined weighted mean (3.50, Very Highly Acceptable), followed by Formulation 1 (3.20) and Formulation 3 (2.80), both Highly Acceptable. Students and teachers rated Formulation 2 Very Highly Acceptable (3.60 and 3.90), whereas parents preferred Formulation 1 (3.30) and rated Formulation 3 only Moderately Acceptable (2.20). The blondies thus retained their characteristic sweet, caramel-like taste with potato flour, although taste preferences differed among consumer groups.

In terms of color, Formulations 1 and 3 were both Highly Acceptable (2.90), whereas Formulation 2 was Moderately Acceptable (2.20) and received Moderately Acceptable ratings from all three groups. Teachers rated Formulation 3 Very Highly Acceptable (3.50). These results suggest that the amount of potato flour affected browning, with Formulation 2 deviating from the expected golden hue of blondies. In terms of appearance, Formulation 3 was Very Highly Acceptable to all three groups and obtained the highest combined weighted mean (3.57), followed by Formulation 1 (3.10) and Formulation 2 (2.97), both Highly Acceptable.

Overall, Formulation 2 was preferred in aroma and taste, whereas Formulation 3 was preferred in texture, color, and appearance, which contributed to its highest overall rating. These results show that adjusting the proportion of potato flour shapes specific sensory attributes and that further refinement, such as adjusting baking time or sugar type for color, could improve the product. The findings are consistent with Discovery Learning Theory, as systematic testing of different ratios revealed how the ingredient influences each attribute (Bruner, 1961), and with the Theory of New Product Development, which emphasizes iterative refinement of sensory attributes to meet consumer preferences (Gurbuz, 2018).

Shelf Life of Potato Gluten-Free Blondies

Shelf life was determined through physical observation over 21 days under ambient storage. From Day 1 to Day 14, the blondies retained their soft and slightly chewy texture, pleasant aroma, and consistent color, with no visible mold, discoloration, or unpleasant odor. On Day 15, the texture became noticeably drier, the aroma changed slightly, the edges became firmer than the center, and small discoloration spots appeared, indicating the early stage of spoilage. From Day 16 to Day 21, visible mold growth appeared and increased, accompanied by

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discoloration, a sour or unpleasant odor, and marked textural changes, rendering the product unsuitable for consumption.

These observations indicate a shelf life of approximately 14 days under the storage conditions of the study. The subsequent deterioration reflects the stability challenges common to gluten-free baked goods (El Khoury et al., 2018) and the susceptibility of bakery products to mold spoilage, which can be controlled through improved packaging, preservatives, and storage conditions (Garcia & Copetti, 2019). Because no microbial or laboratory analysis was conducted, these shelf-life findings should be regarded as preliminary.

Economic Value of Potato Gluten-Free Blondies

Table 5 presents the evaluators' assessment of the economic value of the product. All indicators were rated Very High Viability, with an overall weighted mean of 3.57. The local accessibility, affordability, and ease of procuring raw materials received the highest rating (3.83), followed by the potential of increased potato utilization to raise farmers' and producers' income (3.80) and the product's reasonable price compared with commercial gluten-free baked goods (3.57). The reduction in production and household food expenditures and the suitability of the production cost for small-scale enterprises received the lowest ratings (3.33 each), although both remained Very High.

Table 5. *Economic Value of Potato Gluten-Free Blondies*

Indicator	WM	Int	Rank
The product is reasonably priced and cost-effective compared with commercially available gluten-free baked goods.	3.57	VH	3
The raw materials are locally accessible, affordable, and easy to procure within the community.	3.83	VH	1
Using potato flour as a substitute ingredient reduces production and household food expenditures.	3.33	VH	4.5
Increased utilization of potatoes creates market demand that may raise the income of local farmers and producers.	3.80	VH	2
The overall production cost is economical and suitable for small-scale food enterprises and home-based businesses.	3.33	VH	4.5
Average	3.57	VH	

Note. WM = weighted mean. 3.26–4.00 = Very High Viability (VH); 2.51–3.25 = High Viability; 1.76–2.50 = Low Viability; 1.00–1.75 = Very Low Viability.

Table 6 presents the production cost of one batch of Formulation 3, which yielded 20 pieces. Raw ingredients cost Php 19.00, and packaging, labels, and fuel cost Php 21.00, for a total production cost of Php 40.00. At a selling price of Php 6.00 per piece, total sales amounted to Php 120.00, yielding a projected profit of Php 80.00 per batch.

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Table 6. *Production Cost of One Batch of Potato Gluten-Free Blondies (Formulation 3)*

Item	Unit cost (Php)	Amount (Php)
¼ cup potato flour	30.00 per pack	3.00
1 cup salted butter	58.00 per 200 g	5.00
½ cup brown sugar	65.00 per kg	3.00
½ tsp vanilla	20.00 per bottle	1.00
1 whole egg	7.00 per piece	7.00
Subtotal, raw ingredients		19.00
Plastic containers	0.20 per piece	10.00
Labels	0.25 per piece	1.00
Gas (30 minutes of baking)		10.00
Subtotal, packaging and fuel		21.00
Total production cost		40.00
Total sales (20 pieces × Php 6.00)		120.00
Projected profit		80.00

Note. Costs are based on prevailing local market prices at the time of the study.

These results suggest that potato gluten-free blondies are economically promising for households and small-scale producers, since they rely on locally available raw materials and require modest capital. The strong ratings for raw material accessibility and farmer income indicate that the product can create value across the local agricultural and food sectors. These findings support the Diffusion of Innovations Theory, in which relative advantage, affordability, and low complexity encourage adoption by producers and consumers (Rogers, 2003), and the Theory of New Product Development, which holds that successful products must balance quality with cost-effectiveness (Gurbuz, 2018).

CONCLUSION

Potato flour, produced from locally grown potatoes through drying and pulverization, can be used as the principal flour ingredient in gluten-free blondies through a systematic, replicable Stage-Gate development process. All three formulations were Highly Acceptable, and Formulation 3, containing one-quarter cup of potato flour, obtained the highest overall rating and was preferred in texture, color, and appearance, while Formulation 2 was preferred in aroma and taste. The differences among formulations were not statistically significant, indicating that potato flour performs consistently across the tested proportions and allowing flexibility in formulation.

The blondies remained acceptable for about 14 days under ambient storage before spoilage occurred, indicating the need for shelf-life extension for wider distribution. The product was rated as having very high economic value and can be produced at low cost with a favorable projected profit. Potato gluten-free blondies are therefore a viable, nutritious, and economical alternative for individuals with gluten restrictions and a promising livelihood opportunity that adds value to locally abundant crops.

Recommendation

The standardized Stage-Gate formulation and baking procedures established in this study may be adopted as a reference protocol for developing other gluten-free baked products. Future studies should test additional potato flour concentrations, blend potato flour with other local root-crop flours, and evaluate nutritional composition, crumb structure, moisture retention, and gluten content through laboratory analysis, using larger and more diverse samples of evaluators.

To improve the product, baking time, temperature, or sugar type may be adjusted to achieve a more consistent golden color, particularly for Formulation 2, and small amounts of hydrocolloids or alternative fats may be tested to tailor texture. To extend shelf life, improved packaging materials, oxygen absorbers, natural preservatives, and refrigerated or frozen storage should be evaluated together with microbial testing. Local

government units and agricultural cooperatives are encouraged to link potato farmers with bakers and food enterprises, and micro-entrepreneurs and home-based businesses may adopt the formulation as a low-capital livelihood product.

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