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## Development of Matcha Banana Flour Brownies: A Healthy Product and Community Career Creation through Digital Media

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*Received 16 May 2026; Revised 16 June 2026; Accepted 31 July 2026; Published online 31 July 2026.*

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### Abstract

This academic article presents the development of matcha banana flour brownies from local community resources. The objectives were to analyze the business environment, develop a prototype product, and develop digital marketing media to support community career creation. The process included a survey of community resources and needs, SWOT analysis, formulation trials using banana flour as a wheat flour substitute at 30, 70, and 100 percent, nutrition and simple production cost calculations, sensory acceptance evaluation by experts and consumers, and digital media evaluation. The findings showed that the community had strong potential in raw Namwa banana resources and needed a convenient healthy product. The developed brownie provided approximately 80 kcal per piece. The raw material cost was 22.48 baht per box of four pieces, with a suggested selling price of 70 baht per box. Expert acceptance scores for the 70 and 100 percent banana flour formulas were high, while consumer overall liking averaged 4.06 out of 5. The overall evaluation of digital marketing media was 4.20, interpreted as a high level. The results indicate that matcha banana flour brownies have commercial potential and can support community-based economic development.

**Keywords:** banana flour brownie, matcha, community enterprise, digital marketing

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## **Introduction**

Banana is a local plant that has long been associated with Thai ways of life, traditions, and culture. It is used as food, dessert ingredients, household materials, local wisdom, and cultural objects. Thai communities use almost every part of the banana plant. The fruit can be consumed fresh or processed into Thai desserts and food products; banana leaves are used for food wrapping, natural containers, and traditional activities; and other parts of the plant can be used in agriculture, handicrafts, or household and community waste management. This reflects that banana is not only a food crop but also a local resource and cultural asset. Thailand's community product and One Tambon One Product (OTOP) development approach encourages communities to use local resources while preserving local wisdom, culture, and identity (Food and Agriculture Organization of the United Nations [FAO], 2022). In Lop Buri Province, particularly Chai Badan District, many communities continue to rely on agriculture and possess diverse agricultural resources. In Tha Manao Subdistrict, mixed farming activities include banana, coconut, guava, and mango cultivation, along with fish and shellfish farming for sale. The community later became interested in processing local Namwa bananas into banana flour in order to add value and extend shelf life. In 2023, the Wapahasuk Community Enterprise was established to produce and sell banana flour to health-conscious consumers. The product was packed in 100-gram foil bags and sold through government offices and events organized by the Community Development Office. However, sales remained insufficient to ensure the long-term sustainability of the group. Although banana flour has gained acceptance among health-conscious consumers, the product has mainly been marketed as a raw ingredient, resulting in limited commercial opportunities and inconsistent income generation for the community enterprise. Developing ready-to-eat products with higher market value therefore represents an important strategy for improving the sustainability and competitiveness of community enterprises.

Banana flour has potential as an ingredient in various food products, such as baked goods, bakery products, snacks, and alternative foods for health-conscious consumers. Flour made from unripe or semi-unripe banana contains dietary fiber and resistant starch, which may support digestive health, satiety, and glycemic response (Munir et al., 2024; Sardá et al., 2016). Therefore, the use of banana flour as a main ingredient or partial substitute for wheat flour in bakery products is consistent with current consumer trends emphasizing nutritional value and convenient consumption.

The development of matcha banana flour brownies was therefore designed to connect local resources with the concept of healthy product development. Banana flour was selected as an important ingredient to add value to community raw materials and to transform them into an easy-to-consume baked product suitable for consumers of different ages. Matcha green tea was selected to create a distinctive flavor, color, and healthy product image. Green tea contains catechins, a group of phenolic compounds widely studied for antioxidant properties and general health-related roles (Chacko et al., 2010; Musial et al., 2020). In addition, stevia syrup was used to partially substitute sweetness in response to consumers who wish to reduce sugar intake. Steviol glycosides are used as sweeteners in several food and beverage products and provide sweetness at a lower use level than sugar (Ashwell, 2015; FAO/WHO JECFA, 2017). However, healthy community food product development cannot depend only on ingredient selection. It must also consider sensory quality, safety, convenience, production cost, packaging, product

image, and the ability to communicate product value to consumers. The development process should therefore be systematic, including ingredient study, formula trials, sensory quality evaluation, target consumer identification, brand design, and media communication. Such processes help prepare the prototype for actual community use and possible commercial extension.

Previous studies have demonstrated that banana flour can successfully replace wheat flour in bakery products such as brownies, waffles, and biscuits while maintaining acceptable sensory quality (Daengsangwan et al., 2011; Khummee et al., 2017; Klinmalai et al., 2022). Likewise, several studies have reported that digital media can effectively increase awareness and sales opportunities for community products through online communication and branding strategies (Rothom, 2022; Dongsongkhram, 2024). However, these studies have generally investigated product development and digital marketing as separate issues. Very few studies have integrated local resource utilization, healthy product innovation, business environment analysis, economic feasibility, sensory evaluation, and digital marketing media into a comprehensive framework for sustainable community enterprise development. Furthermore, previous studies have rarely examined how value-added healthy food products can simultaneously enhance consumer acceptance and create long-term income-generating opportunities for community enterprises. Therefore, this study addresses these research gaps by integrating community resource analysis, prototype development of matcha banana flour brownies, nutritional and production cost evaluation, consumer sensory assessment, and digital marketing media development within a single research and development (R&D) framework. The findings are expected to contribute not only to the literature on functional bakery products but also to community entrepreneurship, sustainable local economic development, and digital business promotion.

### **Objectives**

1. To analyze the business environment of matcha banana flour brownies for promoting community careers.
2. To develop a prototype of matcha banana flour brownies as a healthy product for community career creation.
3. To develop digital marketing media for matcha banana flour brownies to support product promotion and sales.

### **Literature Review**

Community product development is a process of using local resources, wisdom, raw materials, and human potential to create new products or improve existing products so that they have quality, uniqueness, and market relevance. A good community product should reflect local identity, meet production standards, use appropriate packaging, and be able to compete in the market. Product development is therefore not limited to production; it also involves raw material analysis, formula design, quality control, target market identification, branding, and marketing communication.

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## **1. Banana Flour as a Functional Ingredient in Healthy Bakery Products**

Recent studies have highlighted banana flour as an emerging functional ingredient because of its high resistant starch, dietary fiber, and bioactive compounds, making it suitable for the development of healthier bakery products (Padam et al., 2014; Falcomer et al., 2019). In particular, unripe banana flour has received considerable attention as a wheat flour substitute due to its potential to improve nutritional quality while maintaining desirable technological properties in baked products (Juarez-Garcia et al., 2006; Ovando-Martínez et al., 2009). Reviews of green banana utilization have further emphasized that the nutritional functionality of banana flour depends on banana cultivar, processing methods, and starch characteristics, all of which influence product quality and consumer acceptance (Falcomer et al., 2019; Padam et al., 2014).

Several studies have reported successful applications of banana flour in bakery and gluten-free products. These studies consistently demonstrated that partial substitution of wheat flour with banana flour can improve dietary fiber content while maintaining acceptable sensory properties (Juarez-Garcia et al., 2006; Ovando-Martínez et al., 2009). In addition, banana flour has been recognized as a promising ingredient for value-added food development because it can contribute to both nutritional enhancement and the utilization of underused agricultural resources (Padam et al., 2014).

Despite these advances, previous studies have primarily concentrated on food formulation, physicochemical characteristics, or nutritional properties. Consumer acceptance has generally been evaluated only as sensory preference, whereas business feasibility, production cost, commercialization, and community-based value creation have received comparatively little attention (Lawless & Heymann, 2010; Stone et al., 2012). Consequently, existing knowledge remains fragmented and does not adequately support sustainable community enterprise development.

## **2. Development of Healthy Community Food Products**

Current consumer demand increasingly favors food products that combine nutritional benefits with convenience and natural ingredients. Functional ingredients such as green tea (matcha) and stevia have therefore been incorporated into bakery products to improve antioxidant potential and reduce sugar intake while maintaining product acceptability (Cabrera et al., 2006; Lemus-Mondaca et al., 2012). Previous studies have shown that successful healthy product development requires balancing nutritional value with sensory quality, production feasibility, and consumer preferences rather than focusing solely on nutritional composition (Lawless & Heymann, 2010; Stone et al., 2012).

However, many previous studies have evaluated individual product attributes independently, including nutritional composition, antioxidant activity, or sensory acceptance. Few studies have adopted an integrated product development approach that simultaneously considers formulation, nutritional value, production cost, packaging, branding, and commercialization potential, particularly for community enterprises producing local agricultural products. This limitation suggests that healthy food innovation should be examined not only as a technical formulation issue but also as a community-based business development process.

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### 3. Digital Marketing and Community Enterprise Development

Digital marketing has become an important mechanism for enhancing the competitiveness of community-based enterprises by expanding market access, strengthening customer engagement, and communicating local product identity (Felix et al., 2017; Taiminen & Karjaluo, 2015). Recent scholarship on digital and social media marketing has highlighted social media, websites, and digital branding as key tools for customer engagement and market expansion (Dwivedi et al., 2021). Nevertheless, existing studies have mainly examined digital marketing from marketing or technology perspectives rather than integrating it with food product innovation and community resource development.

Studies on small and medium-sized enterprises have similarly demonstrated that digital media can improve product awareness and online purchasing opportunities for local products (Taiminen & Karjaluo, 2015). Nevertheless, these studies have generally emphasized communication effectiveness without evaluating whether the promoted products themselves have been systematically developed through evidence-based research or assessed for commercial feasibility. As a result, the relationship between digital marketing and product innovation in community enterprises remains underexplored.

### 4. Research Gap

The literature indicates three major limitations. First, studies on banana flour have primarily emphasized food formulation and nutritional improvement, with limited consideration of business feasibility and sustainable commercialization (Falcomer et al., 2019; Padam et al., 2014). Second, studies on community digital marketing have generally focused on communication strategies independently of product development (Dwivedi et al., 2021; Felix et al., 2017). Third, there is limited empirical evidence integrating local resource utilization, healthy product innovation, consumer sensory evaluation, production cost analysis, business environment analysis, and digital marketing within a single research and development framework.

To address these gaps, the present study integrates community resource analysis, the development of matcha banana flour brownies, nutritional and economic evaluation, consumer sensory assessment, SWOT analysis, and digital marketing media development. Unlike previous studies that examined these components separately, this research proposes a comprehensive community enterprise development model that simultaneously supports healthy food innovation, sustainable entrepreneurship, and local economic development.

## Conceptual framework

The conceptual framework consists of five connected components: (1) community resources and needs, (2) business environment analysis, (3) prototype product development, (4) evaluation of nutrition, cost, and sensory acceptance, and (5) digital marketing media development to create career and income opportunities for the community.

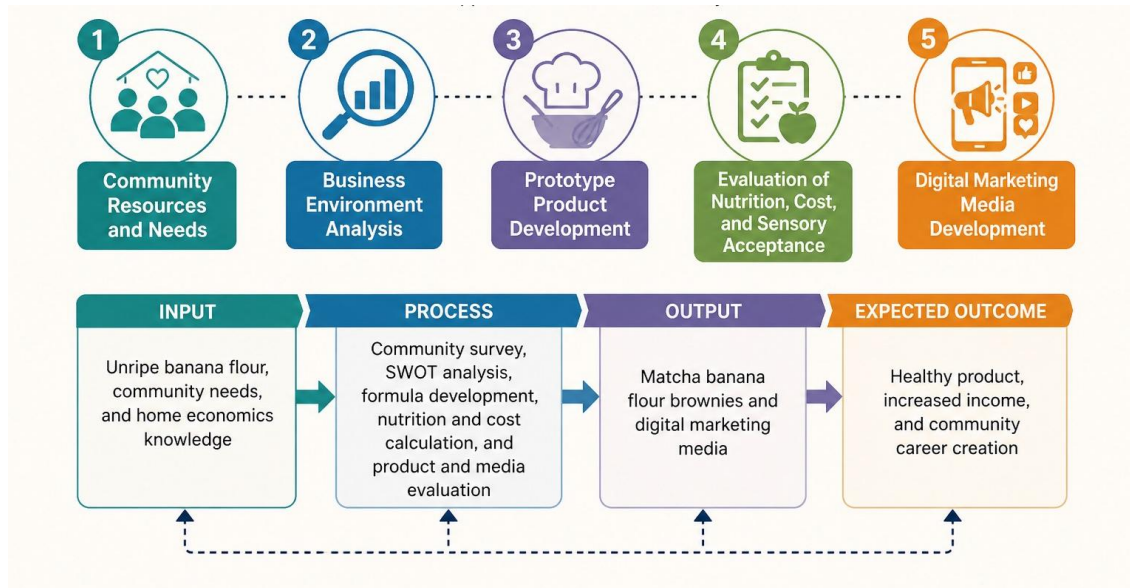


Figure 1 Conceptual framework for developing matcha banana flour brownies

## Research methodology

approach to develop value-added matcha banana flour brownies using locally produced banana flour from the Wapahasuk Community Enterprise, Chai Badan District, Lop Buri Province, Thailand.

### 1. Population and samples

The first group consisted of 10 members of the Wapahasuk Community Enterprise, who were purposively selected because they were directly involved in banana flour production and community product development. The second group comprised 13 community members from Tha Manao Subdistrict, Chai Badan District, Lop Buri Province. These participants were purposively selected to provide information on local resources, community needs, and opportunities for value-added product development. The third group consisted of 20 experts in home economics, food science, food product development, nutrition, or related fields. The experts were selected through purposive sampling based on their professional expertise and experience in product evaluation. The fourth group included 100 general consumers, who were

selected using convenience sampling to participate in the sensory evaluation of the developed product. The fifth group consisted of 30 digital media evaluators, who were purposively selected based on their knowledge or experience in digital communication, online marketing, or community product promotion to evaluate the effectiveness of the developed digital marketing media.

## **2. Research instrument**

The research instruments included a focus group form, a SWOT analysis form, product formulation and production record a 9-point hedonic scale for sensory liking, Sensory evaluation questionnaire using a 5-point hedonic scale and a digital media quality evaluation form, questionnaire using a 5-point scale.

## **3. Collection of data**

Phase 1 surveyed community resources and needs by conducting focus group discussions in the community enterprise area to collect data on raw materials, readiness, and product development needs. The information was analyzed using SWOT analysis.

Phase 2 developed the prototype product by testing banana flour substitution for wheat flour at 30, 70, and 100 percent. Sensory acceptance was evaluated by 20 experts using a 9-point hedonic scale and by 100 general consumers using a 5-point rating scale. The evaluated attributes included appearance, color, aroma, taste, texture, and overall liking. Nutritional value was calculated using Thai Nutri Survey, and simple production cost was calculated.

Phase 3 developed digital marketing media by studying media exposure patterns of health food consumers across age groups, designing media content, and evaluating media quality with 30 evaluators in terms of content, language, visuals, artistic composition, and graphics.

All research instruments were developed based on relevant literature and previous studies. Content validity was evaluated independently by three experts specializing in food science, community enterprise development, and research methodology using the Item-Objective Congruence (IOC) technique. The IOC values ranged from 0.67 to 1.00, indicating acceptable content validity according to the recommended criterion of  $IOC \geq 0.50$ .

Prior to the main study, the questionnaires were pilot-tested with 30 respondents who possessed characteristics similar to those of the target population. Internal consistency reliability was subsequently examined using Cronbach's alpha coefficient, yielding an overall reliability coefficient of 0.89, which exceeded the recommended minimum value of 0.70 and demonstrated satisfactory reliability (Nunnally & Bernstein, 1994; Hair et al., 2019)

## **4. Data analysis**

Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize participant characteristics and evaluation results. Sensory evaluation scores,

consumer satisfaction, and digital media assessment were interpreted using mean score criteria. Qualitative information obtained from interviews and community discussions was analyzed through content analysis to identify themes related to product development, business opportunities, and community enterprise sustainability.

## Results

The business environment analysis showed that the community needed to develop banana flour into a healthy product that was easy to consume, suitable with tea or coffee, and appropriate for consumers of all ages. The banana flour production process used Namwa bananas at approximately 70-80 percent maturity. The bananas were separated, washed, peeled, sliced, soaked in 0.1 percent sodium carbonate solution for 30 minutes, drained, dried in a hot-air oven at 55-60 degrees Celsius until crisp, ground, and sieved through an 80-mesh sieve. The community expected a product that could be sold regularly, served as a snack for visitors and local activities, and marketed online or to other communities.

**Table 1 SWOT analysis of matcha banana flour brownies**

| <b>Factor</b> | <b>Key issue</b>                                                                                                                                                                                 |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Strengths     | Banana flour is low-cost and available in the community. It can be developed into a health-oriented food product.                                                                                |
| Weaknesses    | The product is not yet well known. Production still requires labor and equipment that the community lacks. Some ingredients are expensive, and the product shelf life is approximately one week. |
| Opportunities | The community receives support from public and private agencies. Healthy food consumption is increasing, and consumers across age groups can access social media.                                |
| Threats       | The community is located far from major markets, creating transportation costs. Short shelf life limits online sales, and consumer preferences for healthy foods are diverse.                    |

The prototype development showed that brownie formulas could be adjusted by substituting banana flour for wheat flour at different levels while keeping other ingredients constant, including matcha powder, white chocolate compound, eggs, stevia syrup, salted butter, rice bran oil, salt, and xanthan gum.

**Table 2 Banana flour substitution ratio in brownie formulas**

| <b>Ingredient</b>        | <b>Control formula</b> | <b>Banana flour 30%</b> | <b>Banana flour 70%</b> | <b>Banana flour 100%</b> |
|--------------------------|------------------------|-------------------------|-------------------------|--------------------------|
| Wheat flour              | 90 g                   | 63 g                    | 27 g                    | -                        |
| Banana flour             | -                      | 27 g                    | 63 g                    | 90 g                     |
| Matcha powder            | 12 g                   | 12 g                    | 12 g                    | 12 g                     |
| White chocolate compound | 110 g                  | 110 g                   | 110 g                   | 110 g                    |
| Eggs                     | 2 eggs                 | 2 eggs                  | 2 eggs                  | 2 eggs                   |
| Stevia syrup             | 50 g                   | 50 g                    | 50 g                    | 50 g                     |
| Salted butter            | 30 g                   | 30 g                    | 30 g                    | 30 g                     |
| Rice bran oil            | 20 g                   | 20 g                    | 20 g                    | 20 g                     |
| Salt                     | 2 g                    | 2 g                     | 2 g                     | 2 g                      |
| Xanthan gum              | 1 g                    | 1 g                     | 1 g                     | 1 g                      |

Table 2 shows that the control formula used 90 g of wheat flour. The experimental formulas substituted banana flour at 30, 70, and 100 percent of the total flour amount. Other ingredients were fixed in all formulas to clearly compare the effect of banana flour levels on brownie quality. The production process included preheating the oven to 150 degrees Celsius, beating eggs with stevia syrup until foamy, sifting banana flour, melting butter and white chocolate, adding xanthan gum and matcha powder, gently folding the mixture, pouring it into molds, and baking for approximately 10 minutes.

**Table 3 Mean and standard deviation of liking scores for banana flour brownies**

| <b>Attribute</b> | <b>Banana flour 30%</b> | <b>Banana flour 70%</b> | <b>Banana flour 100%</b> |
|------------------|-------------------------|-------------------------|--------------------------|
| Appearance       | 6.7 ± 0.72              | 7.2 ± 0.64              | 7.5 ± 0.58               |
| Color            | 6.6 ± 0.76              | 7.5 ± 0.61              | 7.8 ± 0.52               |
| Aroma            | 6.5 ± 0.80              | 6.9 ± 0.73              | 7.1 ± 0.68               |
| Texture          | 6.6 ± 0.78              | 7.3 ± 0.62              | 8.0 ± 0.47               |
| Taste            | 6.5 ± 0.82              | 7.4 ± 0.59              | 7.3 ± 0.65               |
| Overall liking   | 6.8 ± 0.70              | 7.3 ± 0.63              | 7.4 ± 0.60               |

*Note: Values are presented as mean ± standard deviation.*

The 100 percent banana flour formula received the highest scores in several attributes, including appearance ( $7.5 \pm 0.58$ ), color ( $7.8 \pm 0.52$ ), texture ( $8.0 \pm 0.47$ ), and overall liking ( $7.4 \pm 0.60$ ). This indicates that complete replacement of wheat flour with banana flour could produce brownies that were well accepted by evaluators, particularly in color and texture.

**Table 4 Sensory acceptance by 100 general consumers**

| <b>Attribute</b> | <b>Mean <math>\pm</math> S.D.</b> |
|------------------|-----------------------------------|
| Appearance       | $4.22 \pm 0.58$                   |
| Taste            | $4.02 \pm 0.66$                   |
| Aroma            | $3.92 \pm 0.72$                   |
| Texture          | $4.04 \pm 0.63$                   |
| Color            | $4.03 \pm 0.61$                   |
| Overall liking   | $4.06 \pm 0.64$                   |

*Note: Values are presented as mean  $\pm$  standard deviation.*

Consumer acceptance scores for all attributes were at a high level. Appearance received the highest mean score ( $4.22 \pm 0.58$ ), followed by overall liking ( $4.06 \pm 0.64$ ), texture ( $4.04 \pm 0.63$ ), color ( $4.03 \pm 0.61$ ), taste ( $4.02 \pm 0.66$ ), and aroma ( $3.92 \pm 0.72$ ).

**Table 5 Approximate nutritional value of matcha banana flour brownie recipes**

| <b>Ingredient</b> | <b>Amount</b> | <b>Kcal</b> | <b>Carbohydrate</b> | <b>Protein</b> | <b>Fat</b> |
|-------------------|---------------|-------------|---------------------|----------------|------------|
| Banana flour      | 90 g          | 108         | 26.1 g              | 1 g            | -          |
| Matcha powder     | 12 g          | 30          | 3 g                 | 1 g            | -          |
| White chocolate   | 110 g         | 592.9       | 65.12 g             | 6.49 g         | 35.3 g     |
| Eggs              | 2 eggs        | 144         | 0.8 g               | 12.6 g         | 9.6 g      |
| Stevia syrup      | 50 g          | 0           | -                   | -              | -          |
| Xanthan gum       | 1 g           | 0           | -                   | -              | -          |
| Butter            | 30 g          | 222         | -                   | -              | 24.6 g     |
| Salt              | 2 g           | 0           | -                   | -              | -          |
| Rice bran oil     | 20 g          | 176.8       | -                   | -              | 20 g       |

The total energy of one formula was 1,273.4 kcal. When divided into 16 pieces, each piece provided approximately 79.58 kcal, or about 80 kcal per piece.

**Table 6 Production cost and expected revenue**

| Item                                      | Key information            |
|-------------------------------------------|----------------------------|
| Raw material cost per formula (16 pieces) | 89.99 baht                 |
| Raw material cost per piece               | 5.62 baht                  |
| Raw material cost per box (4 pieces)      | 22.48 baht                 |
| Selling price per box                     | 70 baht                    |
| Projected revenue at 2,000 boxes/month    | Approximately 140,000 baht |

The raw material cost per formula was 89.99 baht, producing 16 pieces. The raw material cost per piece was 5.62 baht, and the cost per box of four pieces was 22.48 baht. If 2,000 boxes were sold per month at 70 baht per box, projected monthly revenue would be approximately 140,000 baht.

**Table 7 Cost structure and projected profit from expected monthly revenue of 140,000 baht**

| Item                               | Proportion of revenue | Amount (baht) |
|------------------------------------|-----------------------|---------------|
| Raw material cost                  | 30%                   | 42,000        |
| Labor cost                         | 20%                   | 28,000        |
| Overhead and depreciation          | 20%                   | 28,000        |
| Marketing cost                     | 5%                    | 7,000         |
| Administrative cost                | 3%                    | 4,200         |
| Other costs                        | 2%                    | 2,800         |
| Profit before depreciation and tax | 20%                   | 28,000        |

Raw material cost accounted for the largest share at 30 percent of revenue, or 42,000 baht per month. Labor cost and overhead/depreciation each accounted for 20 percent, or 28,000 baht per month. Marketing cost was 5 percent, administrative cost was 3 percent, other costs were 2 percent, and profit before depreciation and tax was 20 percent, or 28,000 baht per month.

**Table 8 Evaluation results of digital media quality for promoting matcha banana flour brownies**

| Evaluation item                  | Mean $\pm$ S.D. | Interpretation |
|----------------------------------|-----------------|----------------|
| Content                          | 4.23 $\pm$ 0.40 | High           |
| Language, font format, and sound | 4.24 $\pm$ 0.47 | High           |
| Images and graphics              | 4.20 $\pm$ 0.49 | High           |

| <b>Evaluation item</b>        | <b>Mean <math>\pm</math> S.D.</b> | <b>Interpretation</b> |
|-------------------------------|-----------------------------------|-----------------------|
| Artistic composition          | 4.21 $\pm$ 0.45                   | High                  |
| Motion of images and graphics | 4.12 $\pm$ 0.52                   | High                  |
| Overall                       | 4.20 $\pm$ 0.36                   | High                  |

The evaluation of digital media quality was at a high level in all aspects. The highest mean was language, font format, and sound (4.24  $\pm$  0.47), followed by content (4.23  $\pm$  0.40), artistic composition (4.21  $\pm$  0.45), images and graphics (4.20  $\pm$  0.49), and motion of images and graphics (4.12  $\pm$  0.52). The overall mean was 4.20  $\pm$  0.36.

## **Discussion**

The study had three objectives: to analyze the business environment, develop a prototype healthy product for community career creation, and develop digital marketing media for product promotion and sales. The findings are discussed according to these objectives.

The findings demonstrate that banana flour produced by the Wapahasuk Community Enterprise can be successfully developed into value-added matcha banana flour brownies with satisfactory consumer acceptance. The sensory evaluation results indicate that the developed product achieved favorable ratings in appearance, aroma, taste, texture, and overall acceptability, suggesting that banana flour can serve as an effective alternative ingredient in healthy bakery products. These findings are consistent with previous studies reporting that banana flour can partially replace wheat flour while maintaining acceptable sensory quality and improving the nutritional profile of bakery products (Juarez-Garcia et al., 2006; Falcomer et al., 2019; Munir et al., 2024).

Unlike previous studies, which mainly focused on product formulation or nutritional characteristics, the present study adopted an integrated research and development (R&D) approach by combining product innovation with community resource utilization, SWOT analysis, production cost evaluation, consumer sensory assessment, and digital marketing media development. This integrated approach demonstrates that community food innovation should not be evaluated solely on product quality but also on its commercial feasibility and potential to strengthen community enterprises. The findings therefore extend previous research by providing a practical framework for transforming local agricultural resources into market-oriented products capable of generating sustainable community income.

The SWOT analysis revealed that the major strengths of the community enterprise include the availability of locally produced banana flour, strong community participation, and the unique identity of locally developed products. However, limitations related to marketing capability and product visibility remain important challenges. The development of digital marketing media in

the present study addressed these limitations by enhancing communication of product value, local identity, and health benefits to potential consumers. This finding supports previous studies suggesting that digital marketing improves customer engagement and market accessibility for small and community-based enterprises (Taiminen & Karjaluo, 2015; Dwivedi et al., 2021). Nevertheless, the present study further demonstrates that digital marketing is considerably more effective when integrated with evidence-based product development rather than being implemented as an isolated promotional strategy.

Another important contribution of this study is the integration of nutritional considerations, consumer preferences, business feasibility, and digital marketing into a single community enterprise development model. Previous studies have generally investigated these aspects independently, making it difficult for community enterprises to translate research findings into practical business applications. By contrast, the present study provides an applicable model that simultaneously supports healthy product innovation, value-added agricultural products, entrepreneurial development, and sustainable local economic growth.

Despite these contributions, this study has several limitations. The research was conducted within a single community enterprise in Lop Buri Province, which may limit the generalizability of the findings to other geographical contexts. Future studies should involve multiple community enterprises, larger consumer samples, and long-term evaluations of business performance and digital marketing effectiveness. Additional research should also investigate consumer purchasing behavior, branding strategies, and the economic impacts of digital commerce on community enterprises.

Overall, the findings successfully address the research gap identified in the literature by demonstrating that integrating local resource utilization, healthy food product development, business feasibility assessment, consumer evaluation, and digital marketing within a single R&D framework can enhance both product competitiveness and community enterprise sustainability. This integrated framework contributes to the literature on functional food innovation, community entrepreneurship, and sustainable local economic development while offering practical implications for other community enterprises seeking to increase the value of local agricultural resources.

## **Suggestions**

### **1. Suggestions based on the research findings**

- 1) The product formula should be improved to achieve better balance in aroma and taste.
- 2) Packaging should be developed to match the healthy product image.
- 3) The product should be tested through actual sales in the community or online channels.

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## **2. Suggestions for application**

- 1) The community can apply the product formula as an additional career opportunity.
- 2) Local agencies or educational institutions can use this study as a model for career training.
- 3) The results can guide the development of other healthy food products from local raw materials.

## **3. Suggestions for future research**

- 1) The glycemic index or the product's effect on blood glucose response should be studied.
- 2) Shelf life and product safety should be investigated.
- 3) Different levels of matcha powder and stevia syrup should be compared.
- 4) The effectiveness of digital media across platforms such as Facebook, TikTok, Instagram, LINE Official Account, and YouTube Shorts should be compared.
- 5) If the product is to be developed for industrial production, additional scientific tests should be conducted.

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