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REVITALIZING MULU BEBE BANANA PEEL WASTE FROM NORTH MALUKU INTO ECONOMICALLY VALUABLE HEALTH PRODUCTS THROUGH THE EMPOWERMENT OF PKK WOMEN IN JATI

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Abstract

Communicable diseases such as tuberculosis (TB), acute respiratory infections (ARI), dengue hemorrhagic fever (DHF), and malaria remain major public health problems in Ternate City, partly due to low community awareness of Clean and Healthy Living Behaviors (Perilaku Hidup Bersih dan Sehat/PHBS). Meanwhile, the abundant waste of *Mulu Bebe* banana peels in the area has the potential to be utilized because it contains bioactive compounds with antibacterial and antioxidant activities. Based on these conditions, a Community Service Program (Pengabdian kepada Masyarakat/PkM) was conducted to empower members of the Family Welfare Empowerment (Pemberdayaan Kesejahteraan Keluarga/PKK) group in Jati Subdistrict through the utilization of *Mulu Bebe* banana peels to produce economically valuable hand sanitizer and herbal tea products. The program was implemented in five stages: (1) socialization on PHBS, the benefits of *Mulu Bebe* banana peels, hand sanitizer and herbal tea formulations, packaging, marketing, and business management; (2) training in the production of hand sanitizer and herbal tea, packaging design, product marketing, and business management; (3) application of appropriate technology in the production process using standardized equipment; (4) intensive assistance and evaluation through monitoring business development; and (5) program sustainability through consultation facilitation and digital promotion. The results demonstrated an increase in participants' knowledge based on comparisons between pre-test and post-test scores, with the number of participants achieving scores above 80 increasing from 19 in the pre-test to 30 in the post-test. The participants also developed practical skills in producing 50 bottles of hand sanitizer and 25 boxes of herbal tea using the appropriate formulations, as well as the ability to create attractive and marketable packaging designs. Furthermore, the participants began to demonstrate the ability to implement both digital and non-digital marketing strategies and maintain simple financial records. In conclusion, the PkM program successfully improved the participants' knowledge and enhanced their social and economic capacities. Hand sanitizer and herbal tea products derived from *Mulu Bebe* banana peels not only contribute to efforts to promote PHBS and prevent communicable diseases but also create opportunities for sustainable new businesses for members of the PKK group in Jati Subdistrict.

Keywords: Community Service Program, banana peel, Mulu Bebe banana, hand sanitizer, herbal tea.

INTRODUCTION

Jati Subdistrict is one of the urban villages in South Ternate District, Ternate City, North Maluku Province, covering an area of 0.87 km². Its geographical location, bordering Central Ternate District, Ternate Island, the Halmahera Sea, and a protected forest area, influences various aspects of community life, including health conditions and access to health services (Badan Pusat Statistik [BPS] Kota Ternate, 2025). Community health is an important concern because the population continues to face both communicable and non-communicable diseases. Data from the Health Statistics Profile of North Maluku Province indicate an increase in the use of health insurance among hospitalized residents, from 73.17% in 2023 to 83.81% in 2024 and 88.25% in 2025 (Badan Pusat Statistik, 2025). This increase indicates a substantial demand for health services and further emphasizes the importance of strengthening sustainable promotive and preventive health interventions at the community level. The disease burden in Ternate City is not limited to non-communicable diseases but also includes several communicable diseases. The 2023 Indonesian Health Survey reported tuberculosis (TB), acute respiratory infections (ARI), dengue hemorrhagic fever (DHF), and malaria as among the communicable diseases of public health concern in Ternate City (Ministry of Health of the Republic of Indonesia, 2023). At the same time, a 2024 report from the Ternate City Health Office

indicated a considerable number of cases of non-communicable diseases, including diabetes mellitus, hypertension, heart disease, and stroke (Ternate City Health Office, 2024). These conditions indicate that communities in North Maluku face a double burden of disease, requiring comprehensive public health strategies. Disease control should therefore not rely solely on curative services but should be strengthened through promotive and preventive approaches involving active community participation.

One relevant promotive and preventive approach is the improvement of Clean and Healthy Living Behavior (Perilaku Hidup Bersih dan Sehat/PHBS). PHBS emphasizes individual, family, and community awareness in adopting behaviors that support health maintenance and disease prevention (Ministry of Social Affairs of the Republic of Indonesia, 2022). Hand hygiene is an important component of infection prevention because hands can serve as a vehicle for the transmission of various microorganisms. The World Health Organization (WHO, 2025) recognizes hand hygiene as an important public health intervention for reducing the transmission of infectious diseases, particularly respiratory infections and diseases associated with inadequate hygiene. Therefore, improving community knowledge and skills related to PHBS, including proper hand hygiene practices, should be implemented continuously and adapted to local community conditions and resources.

In addition to health-related challenges, Jati Subdistrict has locally available resources that have not been optimally utilized. One such resource is the Mulu Bebe banana (Musa acuminata), a banana cultivar that is widely consumed by communities in North Maluku. The high consumption of Mulu Bebe bananas generates a considerable amount of banana peel waste, which is commonly discarded and remains underutilized. Agricultural by-products such as banana peels, however, have the potential to be transformed into value-added products through a waste valorization approach. Hikal et al. (2022) reported that banana peels contain various bioactive compounds, including phenolic compounds and flavonoids, which are associated with antioxidant and antimicrobial activities. The utilization of banana peel waste therefore has the potential to provide dual benefits by reducing organic waste while generating products with functional and economic value.

This potential is particularly relevant to Mulu Bebe banana peels. Rosida et al. (2017) reported that Mulu Bebe banana peel extract exhibited strong antioxidant activity, with an IC_{50} value of 70.41 mg/L, and contained phenolic compounds. These findings indicate that Mulu Bebe banana peel may serve as a potential source of natural bioactive compounds. Furthermore, Burhan (2024) demonstrated the antibacterial activity of Mulu Bebe banana peel extract against Staphylococcus aureus through an in vitro study. These findings provide a scientific basis for considering Mulu Bebe banana peel as a potential raw material for developing natural-based products. However, antioxidant and antibacterial activities demonstrated in extracts cannot be directly equated with the effectiveness of a finished product. Therefore, product development must also consider appropriate formulation, hygienic processing, packaging, product quality, and safety.

The utilization of Mulu Bebe banana peel as a health-related and functional food product has also been explored in previous studies. Amalia et al. (2025) investigated the utilization of Mulu Bebe banana peel waste in a foot sanitizer spray formulation as a natural antiseptic. Meanwhile, Lestari et al. (2017) examined the quality of herbal beverages produced from Mulu Bebe banana peels at different drying temperatures. These studies indicate that Mulu Bebe banana peel has potential not only as a raw material for hygiene-related products but also as an ingredient in herbal beverages, provided that appropriate processing conditions are applied. Nevertheless, previous studies have primarily focused on the biological characteristics, formulation, or processing quality of the material. The integration of these scientific findings into a community empowerment program involving production, packaging, marketing, and business management remains insufficiently explored.

This situation is particularly relevant because the target community in Jati Subdistrict has limited knowledge and skills in utilizing Mulu Bebe banana peel as a raw material for value-added products. Based on the analysis of the partners' existing conditions, two major areas of concern were identified. The first is the social and community aspect, including limited knowledge of PHBS, the potential benefits of bioactive compounds in Mulu Bebe banana peel, and the skills required to formulate and produce hand sanitizer and herbal tea. The second is the management aspect, including limited knowledge and skills in product packaging design, digital and non-digital marketing strategies, and small-scale business management. These conditions indicate that the required intervention should extend beyond health education and include knowledge transfer, practical skills training, appropriate technology application, intensive assistance, and entrepreneurship capacity building.

Empowering members of the PKK organization in Jati Subdistrict represents a rational strategy because the organization has an established community structure and is actively involved in health, family welfare, social, and economic activities. A group-based empowerment approach allows knowledge and skills to be transferred through participatory activities and increases the likelihood of program sustainability. The development of health-related and functional food products based on local resources may also contribute to community economic development when

accompanied by appropriate packaging, marketing, and business management skills. Thus, the utilization of Mulu Bebe banana peel can serve not only as an approach to reducing organic waste but also as a local-resource-based innovation that integrates health, environmental, and economic dimensions.

Based on these conditions, a Community Service Program (Pengabdian kepada Masyarakat/PkM) is needed to integrate health education, local resource utilization, and economic empowerment. The problem-solving strategy consists of five main stages: (1) socialization concerning PHBS, the bioactive potential of Mulu Bebe banana peel, hand sanitizer and herbal tea formulation, packaging, marketing, and business management; (2) training in the production of hand sanitizer and herbal tea, packaging design, marketing, and business management; (3) application of appropriate technology and standardized equipment in the production process; (4) intensive assistance and evaluation through monitoring of participants' knowledge, skills, production activities, and business management; and (5) strengthening program sustainability through consultation and digital promotion. This approach is designed to ensure that the program extends beyond knowledge improvement and results in practical skills and sustainable business capacity.

Therefore, this Community Service Program aims to improve the knowledge and awareness of PKK members in Jati Subdistrict regarding PHBS and the utilization of Mulu Bebe banana peel, enhance their skills in processing banana peel waste into hand sanitizer and herbal tea, and strengthen their capacity in product packaging, marketing, and business management. The program is expected to contribute to the development of a community empowerment model based on local resources that integrates promotive and preventive health efforts with waste utilization and economic development. Through this approach, Mulu Bebe banana peel can be transformed from an underutilized agricultural waste into a local resource with potential health, environmental, and economic value for the community of Jati Subdistrict.

LITERATURE REVIEW

1. Hand Hygiene, Clean and Healthy Living Behavior, and Disease Prevention

Clean and Healthy Living Behavior (Perilaku Hidup Bersih dan Sehat/PHBS) represents an important promotive and preventive approach in improving community health. PHBS emphasizes individual and collective awareness in adopting healthy behaviors, including maintaining personal hygiene and environmental sanitation. In the context of communicable disease prevention, hand hygiene is particularly important because contaminated hands can facilitate the transmission of infectious microorganisms. Therefore, improving community knowledge and skills related to hand hygiene is an essential component of sustainable disease-prevention strategies. The importance of hand hygiene has been reinforced by the World Health Organization (WHO), which identifies hand hygiene in community settings as an important public health intervention, particularly for reducing acute respiratory infections and diarrheal diseases. The WHO guidelines recommend regular hand hygiene using soap and water or an alcohol-based hand rub (ABHR) containing at least 60% alcohol when hands are not visibly dirty (World Health Organization [WHO], 2025). These recommendations indicate that access to appropriate hand-hygiene products must be accompanied by adequate knowledge, behavioral change, and a supportive environment. Consequently, health promotion programs should not merely provide health products but should also strengthen community capacity to use them appropriately and consistently. In Indonesia, the PHBS framework similarly emphasizes the development of health-oriented behaviors through education and community participation (Kementerian Sosial Republik Indonesia [Kemensos RI], 2022; Departemen Kesehatan Republik Indonesia [Depkes RI], 2023). This framework is particularly relevant to communities experiencing a burden of communicable diseases, where preventive behaviors can contribute to reducing exposure to infectious agents. Therefore, strengthening PHBS knowledge among members of the PKK group in Jati Subdistrict constitutes an important foundation for the present community service program.

2. Bioactive Potential of Mulu Bebe Banana Peel

Banana peel is generally regarded as an agricultural by-product, although scientific evidence indicates that it contains a range of bioactive compounds with potential health and technological applications. A comprehensive review by Hikal et al. (2022) reported that banana peels contain phenolic compounds, flavonoids, tannins, and other secondary metabolites associated with antioxidant and antimicrobial activities. These characteristics make banana peel a promising raw material for converting agricultural waste into value-added products rather than simply disposing of it. The potential of banana peel is particularly relevant to Mulu Bebe banana (Musa acuminata), a locally important banana cultivar in North Maluku. Rosida et al. (2017) investigated the antioxidant activity and total phenolic content of Mulu Bebe banana peel extract and reported strong antioxidant activity, with an IC_{50} value of 70.41 mg/L. The finding provides a scientific basis for considering Mulu Bebe banana peel as a potential source of natural antioxidant compounds. However, antioxidant activity demonstrated through an in vitro assay should not be interpreted directly as evidence of clinical efficacy in humans. Rather, it establishes the biochemical potential of the

raw material and provides a basis for further product development. The presence of bioactive compounds in banana peels has also been associated with antimicrobial activity. Burhan (2024) specifically examined the antibacterial effectiveness of Mulu Bebe banana peel extract against Staphylococcus aureus using an in vitro approach. This study is particularly relevant to the present program because it provides evidence that the local cultivar has antibacterial potential. Nevertheless, because the study focused on an extract and laboratory inhibition rather than the final formulated product, further formulation and quality evaluation are necessary before claims concerning the effectiveness of a finished hand sanitizer can be made.

3. Utilization of Banana Peel as a Value-Added Health Product

The conversion of agricultural waste into useful products is consistent with the concept of waste valorization, which seeks to transform low-value by-products into materials with greater functional and economic value. Putra et al. (2022) emphasized that banana peel contains bioactive and functional components that can potentially be recovered through different extraction and processing approaches. Such valorization can simultaneously address environmental problems associated with agricultural waste and create opportunities for new value chains. The development of health-related products from Mulu Bebe banana peel has already been explored in several local studies. Amalia et al. (2025) investigated the utilization of Mulu Bebe banana peel in a foot sanitizer spray formulation as a natural antiseptic. This research is important because it demonstrates the transition from laboratory-level investigation of banana peel bioactivity toward a topical hygiene product. However, the study primarily addresses product formulation, while the integration of product development with community education, packaging, marketing, and small-business management remains less explored.

The utilization of Mulu Bebe banana peel is not limited to topical hygiene products. Lestari et al. (2017) examined the quality of herbal beverages made from Mulu Bebe banana peel under different drying temperatures. Their findings indicate that processing conditions, particularly drying temperature, are important factors influencing the quality of the resulting herbal beverage. This evidence is relevant to the development of banana peel herbal tea because processing must be carefully controlled to obtain a product that is acceptable in terms of quality and safety. Taken together, these studies demonstrate that Mulu Bebe banana peel has potential for development into both topical hygiene products and herbal beverages. However, existing research has generally focused on specific scientific or technical aspects, such as antioxidant activity, antibacterial activity, formulation, or processing conditions. The integration of these findings into a community-based empowerment model remains an important area for further development.

4. Community Empowerment and Local Economic Development

Community empowerment provides a framework for transforming local resources into sustainable social and economic benefits. In this context, empowerment should extend beyond the transfer of technical knowledge to include the development of practical skills, decision-making capacity, entrepreneurship, and the ability to manage economic activities independently. The PKK institution provides a suitable social structure for this approach because its members are organized and routinely participate in community activities related to health, family welfare, education, and the local economy. The development of community-based products requires an integrated approach. Technical skills in processing raw materials must be accompanied by knowledge of packaging, product positioning, marketing, financial management, and business sustainability. Previous community empowerment activities involving health-oriented products have demonstrated the relevance of combining technical training with entrepreneurial development (Haris et al., 2023). Such an approach is particularly important for the Jati PKK group because the objective of the present program is not only to produce hand sanitizer and herbal tea but also to develop the capacity of participants to manage these products as potential small-scale businesses. From a theoretical perspective, this approach is consistent with the principle of community-based empowerment, in which local communities are positioned not merely as recipients of assistance but as active actors in identifying problems, utilizing local resources, developing solutions, and sustaining program outcomes. Accordingly, the transformation of Mulu Bebe banana peel into value-added products can simultaneously address three dimensions: health promotion, environmental sustainability, and economic empowerment.

5. Research Gap and Contribution of the Present Program

The literature reviewed above indicates that previous studies have established several important foundations. First, PHBS and hand hygiene are recognized as important components of communicable disease prevention (Depkes RI, 2023; Kemensos RI, 2022; WHO, 2025). Second, banana peel contains bioactive compounds associated with antioxidant and antimicrobial activities (Hikal et al., 2022). Third, studies specifically examining Mulu Bebe banana peel have demonstrated antioxidant activity (Rosida et al., 2017), antibacterial potential against S. aureus (Burhan, 2024), potential application in a sanitizer spray formulation (Amalia et al., 2025), and feasibility as a raw material for herbal beverages (Lestari et al., 2017). These studies provide a strong scientific foundation for utilizing Mulu

Bebe banana peel as a local resource. Nevertheless, a gap remains between scientific evidence concerning the bioactive potential of Mulu Bebe banana peel and its implementation as an integrated community empowerment strategy. Existing studies have predominantly examined the biological activity, formulation, or processing characteristics of the material. Less attention has been given to combining health education, waste utilization, product formulation, packaging development, marketing, and small-scale business management within a single community-based intervention.

The present Community Service Program (PkM) addresses this gap by integrating health promotion through PHBS education with the utilization of Mulu Bebe banana peel for the development of hand sanitizer and herbal tea. The program further extends beyond product production by providing training in packaging design, digital and non-digital marketing, and simple financial management. Thus, its contribution lies not merely in demonstrating the potential of banana peel as a value-added material, but in developing an integrated empowerment model that connects local biological resources with health promotion, environmental sustainability, and community economic development. This integrated approach is expected to strengthen the capacity of PKK members in Jati Subdistrict to utilize locally available resources independently and sustainably. Importantly, the program positions Mulu Bebe banana peel not simply as agricultural waste, but as a locally available resource that can support innovation, health-oriented behavior, and potential household-scale economic activities.

METHOD

The Community Service Program (Pengabdian kepada Masyarakat/PkM) was implemented using a participatory community empowerment approach consisting of five stages: (1) socialization, (2) training, (3) technology application, (4) assistance and evaluation, and (5) program sustainability. The target participants were members of the Family Welfare Empowerment (Pemberdayaan Kesejahteraan Keluarga/PKK) organization in Jati Subdistrict, South Ternate District, Ternate City, North Maluku. Participants were selected based on their active involvement in community activities and their potential to continue the production and marketing of the developed products independently.

4.1 Socialization

The socialization stage began with activity planning, coordination with the local government, and scheduling of the program. The local government was involved in the official opening of the activity, while PKK members and community representatives in Jati Subdistrict were invited as participants. Preparations included providing the activity venue, banners, stationery, educational materials, and pre-test and post-test questionnaires. At the beginning of the activity, participants completed a pre-test to assess their initial knowledge. The socialization materials covered Clean and Healthy Living Behavior (PHBS), the potential of Mulu Bebe banana peel as a source of antibacterial and antioxidant compounds, the formulation of Mulu Bebe banana peel into hand sanitizer and herbal tea, product packaging, marketing strategies, and small-scale business management. After the educational session, participants completed a post-test to evaluate changes in their knowledge following the intervention.

4.2 Training

The training stage focused on improving participants' practical skills in producing hand sanitizer and herbal tea from Mulu Bebe banana peel. The training materials included hand sanitizer and herbal tea formulation, hygienic production procedures, product packaging, attractive packaging design, digital and non-digital marketing strategies, and small-scale business management. Participants received direct guidance during the production process, including preparation of raw materials, processing, formulation, packaging, and product promotion. Digital marketing training introduced the use of Instagram, TikTok, Facebook, and WhatsApp Business as promotional media, while non-digital marketing strategies included direct sales and community-based promotion. The participants' knowledge was evaluated by comparing their pre-test and post-test scores, while practical skills were assessed through direct observation during the production process and evaluation of the products produced. The assessment considered the conformity of the production process with the prescribed formulation, product quality, packaging, and product presentation.

4.3 Technology Application

The technology application stage involved implementing research-based knowledge on the processing of Mulu Bebe banana peel into hand sanitizer and herbal tea products. The production process followed hygienic principles and involved the use of personal protective equipment (PPE), including gloves, masks, and aprons. The equipment used included a Blender Blenz Series, Krisbow water boiler, glass measuring cups, and product packaging. The blender was used to process the raw materials, while the water boiler supported the preparation of the herbal tea. Glass measuring cups were used to ensure appropriate proportions during formulation. Product packaging was designed to protect the products, maintain product quality, and improve their attractiveness and marketability.

Educational pamphlets were also provided to facilitate participants' understanding of PHBS, the potential benefits of Mulu Bebe banana peel, product processing, and proper product use. In addition, digital technology was applied to support product promotion through social media platforms, thereby expanding the potential market and facilitating communication with consumers.

4.4 Assistance and Evaluation

Intensive assistance was provided by the Community Service Program team to ensure that the partners were able to independently conduct production, packaging, and marketing activities. Assistance focused on identifying technical problems, improving production procedures, developing product packaging, implementing marketing strategies, and maintaining simple business records. Monitoring and evaluation were conducted in the sixth month through a direct visit to the partners' business location. Evaluation indicators included the number of products sold, with a minimum target increase of 30%; consumer testimonials and responses; marketing activities; transaction records; and repeat orders. The evaluation also assessed the partners' ability to independently produce, package, market, and manage the developed products.

The results of the evaluation were used to identify obstacles encountered by the partners and to provide appropriate solutions and corrective measures. Data obtained from the pre-test and post-test were analyzed descriptively by comparing the mean scores before and after the intervention. Changes in practical skills were assessed through observations of the production process and the products produced, while business development was evaluated based on sales, consumer responses, transaction records, and repeat orders.

4.5 Program Sustainability

Program sustainability was supported through the continued role of the Community Service Program team as facilitators after the main activities were completed. The team continued to provide consultation and business assistance according to the needs of the partners. PKK members were encouraged to continue producing and marketing hand sanitizer and herbal tea independently through both direct sales and digital marketing platforms. Periodic monitoring was conducted to assess production continuity, product marketing, business development, and financial record-keeping. The sustainability strategy was designed to ensure that the knowledge and skills acquired during the program could be maintained and further developed by the partners. In the long term, the program is expected to support the sustainable utilization of Mulu Bebe banana peel waste, strengthen community health awareness, and create new economic opportunities for PKK members in Jati Subdistrict.

RESULTS AND DISCUSSION

5.1 Implementation of the Community Service Program

The Community Service Program (Pengabdian kepada Masyarakat/PkM) was implemented in Jati Subdistrict, South Ternate District, Ternate City, North Maluku, from July to October 2026. The initial socialization, workshop, and formulation training were conducted on July 7, 2026, at the Jati Subdistrict Hall. The second training and mentoring session was conducted on July 22, 2026, at the Jati PKK Hall. The second session focused on practical assistance in the formulation and packaging design of Mulu Bebe banana peel hand sanitizer and herbal tea, as well as training in product marketing and business management.

The program was implemented according to the planned sequence, consisting of socialization, training, technology application, assistance and evaluation, and program sustainability. The activities involved representatives of the local government, the implementation team, residents of Jati Subdistrict, and PKK members as the primary community partners. A total of 30 participants were involved in the activities. The active participation of community members throughout the program indicates that the intervention was relevant to the needs and conditions of the target community.

5.2 Improvement in Community Knowledge and Skills

The first priority addressed by the program was the social and community aspect, particularly the limited knowledge of PHBS, the potential of Mulu Bebe banana peel, and the ability to formulate health-related products. The intervention was conducted through health education, workshops, demonstrations, and direct practical training. The evaluation demonstrated an improvement in participants' knowledge following the intervention. Before the educational activities, 19 participants achieved a score of ≥80%, whereas after the intervention, 30 participants achieved the same threshold. Thus, the number of participants reaching the predetermined competency level increased by 11 participants, equivalent to a 57.9% increase relative to the pre-intervention number. This result indicates that the educational and training activities were effective in improving participants' understanding of PHBS and the utilization of Mulu Bebe banana peel. The increase in knowledge is important because knowledge is an essential component of health behavior change. The PHBS approach emphasizes the importance of community awareness and active participation in adopting behaviors that support health and disease prevention. Similarly, WHO (2025)

emphasizes hand hygiene as an important public health intervention for reducing the transmission of infectious diseases. Therefore, the increase in participants' knowledge provides an important foundation for strengthening preventive health practices within the community.

In addition to knowledge improvement, participants demonstrated increased practical skills in processing Mulu Bebe banana peel into value-added products. The training resulted in the production of 50 bottles of hand sanitizer and 25 boxes of herbal tea. The ability of participants to complete the production process represents an important achievement because previous conditions indicated limited knowledge and skills in product formulation. The results are consistent with previous research demonstrating the potential of Mulu Bebe banana peel as a source of bioactive compounds. Rosida et al. (2017) reported antioxidant activity in Mulu Bebe banana peel extract, while Burhan (2024) demonstrated antibacterial activity against Staphylococcus aureus in vitro. These findings provide a scientific basis for introducing the raw material to the community. However, the present program primarily demonstrates the participants' ability to process the material into products and does not constitute a clinical evaluation of the health efficacy of the finished products.

5.3 Development of Product Packaging and Marketing Capacity

The second priority addressed by the program concerned management capacity, particularly product packaging, marketing, and small-scale business management. Prior to the intervention, the partners had limited knowledge and skills in designing attractive packaging and developing systematic marketing strategies. The training and mentoring activities resulted in the development of product packaging for both hand sanitizer and herbal tea. Participants successfully prepared 150 primary and secondary packaging designs for the hand sanitizer and 25 boxes of herbal tea. The packaging was designed to be visually attractive, informative, and appropriate for marketing. Product labels included relevant information such as product composition, expiration date, batch number, and instructions for use. The development of appropriate packaging is important because packaging not only protects the product but also functions as a communication and marketing tool. Attractive and informative packaging can increase product visibility and facilitate consumer understanding of the product. In community-based entrepreneurship, packaging skills are therefore an important component of product competitiveness.

Image 1. Mube Hand Hand Sanitizer and Mube Tea Herbal Tea Products Made from Mulu Bebe Banana Peel Waste, Including Their Packaging and Logo Designs

The partners also developed digital and non-digital marketing channels. Fifty bottles of hand sanitizer and 25 boxes of herbal tea were displayed at the PKK office as an offline sales outlet. In addition, business accounts were established on Instagram, TikTok, Facebook, and WhatsApp Business to support digital promotion. The establishment of these channels represents an improvement in the partners' marketing capacity because it allows products to be promoted beyond the immediate local community.

The use of digital marketing is particularly relevant for small-scale community businesses because social media provides relatively accessible channels for product promotion and consumer interaction. Nevertheless, the present program focused primarily on establishing the partners' marketing capacity and infrastructure. Long-term sales growth requires continuous content development, market evaluation, consumer engagement, and consistent product quality.

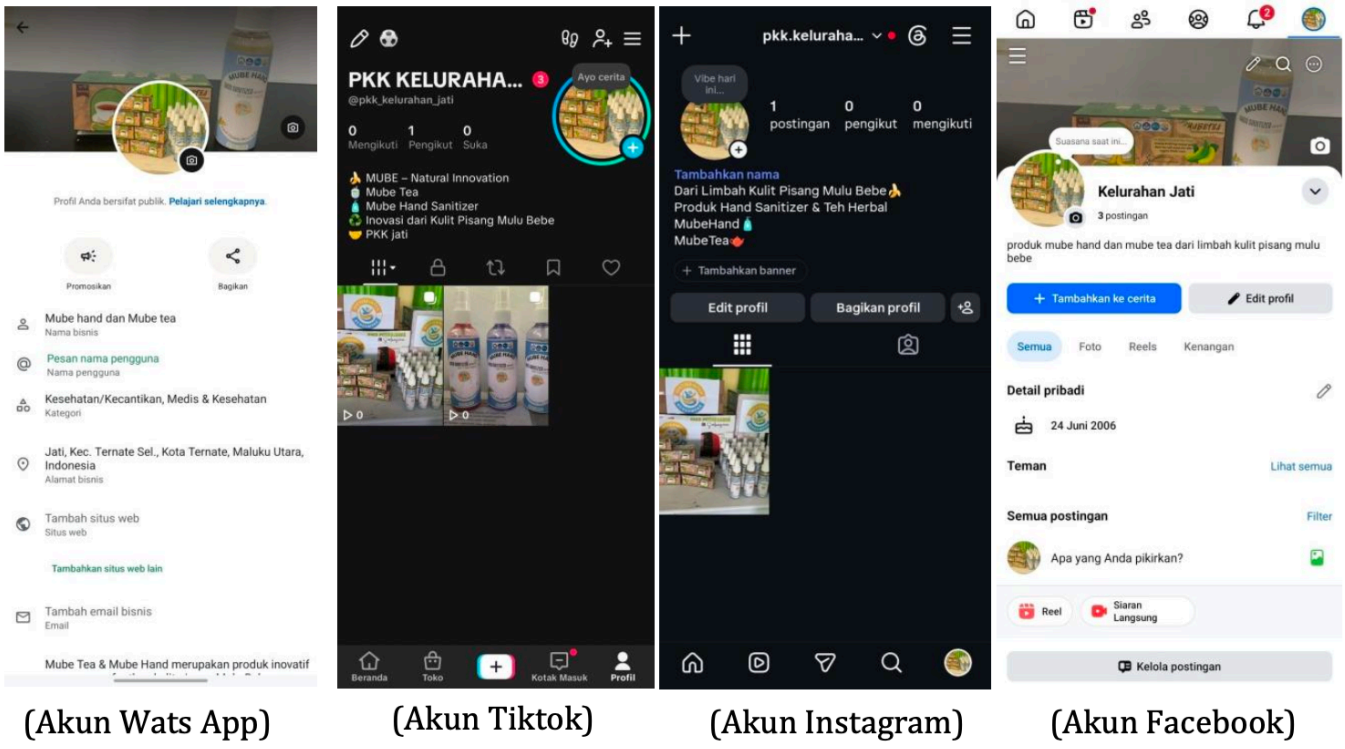

Image 2. Social Media Accounts of Mube Hand and MubeTea

5.4 Development of Small-Scale Business Management

Another important outcome was the improvement of the partners' ability to manage a small-scale business. Training covered basic business management, including capital management, operational costs, revenue, profit, and transaction recording. As a result, a simple business management system and cash-flow recording template were established. The implementation of simple financial records is important for ensuring that the partners can distinguish between production costs, operating expenses, revenue, and profit. Without systematic financial records, small community-based businesses may experience difficulties in evaluating profitability and determining appropriate selling prices. Therefore, the introduction of simple cash-flow management represents an important step toward strengthening the partners' economic independence.

The development of business management capacity complements the technical training in product production. Previous community empowerment programs have shown that technical product development is more likely to generate sustainable economic benefits when accompanied by entrepreneurship and business management training (Haris et al., 2023). Thus, the present program integrates product innovation with managerial capacity rather than treating production as an isolated activity.

5.5 Technology and Innovation Products

The program produced both physical and non-physical technology and innovation outputs. The physical products included MubeHand, a hand sanitizer developed using Mulu Bebe banana peel extract, and MubeTea, an

herbal tea prepared from dried Mulu Bebe banana peel. Supporting production equipment included a Blender Blenz Series, Krisbow water boiler, glass measuring cups, oven, and other production equipment provided to the partners. The MubeTea product was prepared using dried Mulu Bebe banana peel without additional ingredients. This approach emphasizes the utilization of local raw materials and the conversion of agricultural waste into a value-added product. Previous research by Lestari et al. (2017) demonstrated the feasibility of producing herbal beverages from Mulu Bebe banana peel and highlighted the importance of drying temperature in determining product quality.

The non-physical innovations included a PHBS pocketbook, educational leaflets concerning the potential benefits of Mulu Bebe banana peel, knowledge and skills transfer, packaging and marketing training, and a simple cash-flow management system. Digital and non-digital product displays were also established through social media accounts and an offline product display at the PKK office. The combination of physical and non-physical innovations is important because the sustainability of community-based innovation depends not only on the availability of equipment and products but also on the ability of the community to operate, manage, market, and develop them independently.

5.6 Community Participation and Program Relevance

Community participation was observed throughout the implementation of the program. Thirty participants consisting of PKK members and community representatives attended the socialization and training activities. Participants were directly involved in product formulation, production, packaging design, marketing, and business management. The high level of participation indicates that the program was aligned with the partners' needs and local potential. The utilization of Mulu Bebe banana peel also provided a direct connection between the intervention and a resource that is familiar and accessible to the community. This local-resource-based approach can increase the relevance and acceptability of community empowerment programs because participants are not required to rely on unfamiliar raw materials or technologies.

The program also addressed three interconnected dimensions: health, environmental utilization, and economic empowerment. From a health perspective, PHBS education strengthened participants' knowledge concerning preventive health practices. From an environmental perspective, the program introduced an alternative use for banana peel waste. From an economic perspective, the resulting products created potential opportunities for small-scale entrepreneurship among PKK members.

5.7 Impact, Productivity, and Sustainability

The program generated measurable outcomes in terms of knowledge, production capacity, packaging, marketing infrastructure, and business management. The increase in the number of participants achieving a score of ≥80%, from 19 to 30 participants, indicates improved knowledge following the intervention. In terms of productivity, the partners successfully produced 50 bottles of hand sanitizer and 25 boxes of herbal tea. The partners also developed product packaging, established digital marketing accounts, prepared an offline sales display, and implemented a simple financial recording system.

These outcomes demonstrate that the program extended beyond knowledge transfer to the development of practical community capacity. The availability of production equipment and the transfer of technical knowledge provide the partners with resources to continue production after the formal intervention. Meanwhile, digital and non-digital marketing channels provide mechanisms for maintaining product promotion.

However, the sustainability of the business cannot yet be concluded solely from the initial production outputs. Continued production, actual sales performance, repeat purchases, consumer satisfaction, product quality, and financial profitability need to be monitored over a longer period. The sixth-month monitoring plan is therefore important for determining whether the initial outputs can be translated into sustained economic outcomes. The utilization of Mulu Bebe banana peel also supports the broader concept of waste valorization. Banana peels contain bioactive compounds and have potential for conversion into value-added products (Hikal et al., 2022). The present program extends this concept from laboratory-level or product-level utilization toward community-based application by integrating raw-material utilization with health education, product development, marketing, and entrepreneurship.

Overall, the results indicate that the Community Service Program successfully strengthened the knowledge and practical capacity of PKK members in Jati Subdistrict. The program produced tangible outputs in the form of MubeHand hand sanitizer, MubeTea herbal tea, product packaging, marketing channels, educational materials, and a simple business management system. More importantly, the intervention established an integrated model linking local-resource utilization with health promotion, environmental awareness, and economic empowerment. Further monitoring is required to determine the long-term sustainability, market performance, and economic impact of the products developed through the program.

CONCLUSION

The Community Service Program (PkM) successfully addressed the identified health, environmental, and economic challenges in Jati Subdistrict through the utilization of Mulu Bebe banana peel as a locally available resource. The program responded to the limited knowledge of Clean and Healthy Living Behavior (PHBS), the potential utilization of Mulu Bebe banana peel, and the partners' limited skills in product development and small-scale business management. Through five stages consisting of socialization, training, technology application, assistance and evaluation, and program sustainability, the program strengthened the capacity of PKK members to transform locally available banana peel waste into value-added products.

The results demonstrated an improvement in participants' knowledge, with the number of participants achieving a score of ≥80% increasing from 19 participants in the pre-test to 30 participants in the post-test. The participants also acquired practical skills in producing 50 bottles of Mube Hand hand sanitizer and 25 boxes of MubeTea herbal tea. In addition, the program improved participants' capacity in product packaging, digital and non-digital marketing, and simple financial management. The establishment of product packaging, social media business accounts, an offline product display, and a simple cash-flow recording system further strengthened the partners' readiness to develop the products as community-based business activities.

The program therefore demonstrates that the integration of health education, local resource utilization, appropriate technology, and entrepreneurship training can provide a relevant community empowerment approach. The utilization of Mulu Bebe banana peel not only offers an alternative approach to reducing the underutilization of organic waste but also creates opportunities for developing locally based products with potential social, environmental, and economic benefits. However, the current results primarily demonstrate improvements in knowledge, skills, production capacity, and business readiness; therefore, further evidence is required to establish long-term health, market, and economic impacts.

For future implementation, the program should be continued through periodic monitoring of production, sales, consumer acceptance, and financial performance. Further product quality, safety, stability, and efficacy testing is also recommended to strengthen the scientific and commercial basis of Mube Hand and MubeTea. In addition, future activities should focus on strengthening digital marketing, expanding market networks, improving product standardization and licensing, and developing the PKK group toward a sustainable community-based microenterprise. These developments are expected to ensure that the benefits of the program can be sustained and expanded beyond the initial implementation period.

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