

# Farmer empowerment through training on palm sugar standardization in Eastern Coastal Region of North Sumatera

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## ABSTRACT

The production of palm sugar in Indonesia has great economic potential but is mostly carried out traditionally without quality standards. This condition reduces the competitiveness, selling value, and market access of local products. This community service activity, conducted in Sungai Ular Village, Teluk Belida street, Secanggang District, Langkat Regency, North Sumatra Province, aims to enhance local producers' skills in manufacturing standardized palm sugar that meets the Indonesian National Standard (SNI 3743:2021). The method included socialization, technical training, application of appropriate technology, production mentoring, and quality evaluation. Ten local artisans participated and were trained in hygienic production, modern packaging, and digital marketing. The results showed an 80 percent improvement in participants' skills, a 20 percent increase in production efficiency, and the creation of two new product variants: palm sugar granules and palm syrup. This program successfully formed the "Kelompok Usaha Gula Aren Sungai Ular" business group, which now produces the branded product "Gula Aren Sungai Ular" with PIRT (Pangan Industri Rumah Tangga) certification and active digital branding. The training serves as a model of community economic empowerment based on local potential and cultural identity.

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## 1. INTRODUCTION

Small-scale household industries in rural areas play a significant role in processing agro-industrial yields as local commodities, thereby fostering economic value within the community. A prominent example of such a commodity is palm sugar, derived from the processing of sap by small-scale artisans. Currently, the majority of these producers rely on conventional methodologies and rudimentary equipment, which often results in suboptimal production capacities and inconsistent product quality. Such technical limitations inherently diminish the added value and competitive edge of these products in increasingly rigorous markets (Gobel et al., 2023; Simamora, 2022). Consequently, there is an exigent need for enhancing production standards and bolstering management frameworks to ensure the sustainable growth of these cottage industries. These constraints not only reduce profitability but also undermine market positioning (Gobel et al., 2023). Within the framework of local economic development,

strengthening production capacity and business governance is essential for enabling home industries to evolve sustainably and provide a substantive contribution to the collective economy (Aprieni et al., 2024; Juanda et al., 2023).

The sugar palm (*Arenga pinnata*) is a versatile plantation commodity with high economic value because nearly all parts of the plant can be used for various purposes (Suri et al., 2024). In addition to producing sap as the main material for palm sugar, the trunks, leaves, and fruits are also utilized for both food and non-food needs (Suri et al., 2024; Wicaksana et al., 2024). Unlike sugarcane, the production of palm sugar depends heavily on the skills of tapping and processing the sap, which has specific chemical characteristics. The content of the sap, including carbohydrates, proteins, fats, and water, is influenced by the age of the tree, soil conditions, and the climate (Setiawan, 2020). Besides acting as a natural sweetener, palm sugar provides a unique color, aroma, and taste to many traditional and modern food products (Simamora, 2022). Nationally, palm sugar processing has become a promising business opportunity for rural communities. The most common product is molded palm sugar, which is produced from the male flower clusters of the tree (Hutami et al., 2023).

Local producers produce palm sugar by processing sap collected directly from sugar palm trees at heights of approximately 7 to 15 meters. This process has been passed down through generations, with local communities continuing to utilize traditional techniques (Suri et al., 2024). Generally, the production of palm sugar begins with tapping the sap from the flower clusters of the tree, then boiled until it thickens and crystallizes into molded sugar or other derivative products (Hutami et al., 2023; Radam & Rezekiah, 2015). The quality of the sugar is strongly influenced by the chemical characteristics of the processed sap, which typically contains carbohydrates, proteins, water, and several minor components. This composition can be affected by various factors, including the age of the plant, environmental conditions, and the specific tapping methods employed (Meikapasa et al., 2025a; Setiawan, 2020).

In its development, palm sugar processing has become a potential economic activity for the community, particularly within the scope of micro and small-scale enterprises. Molded palm sugar, which is derived from sap processing, is widely produced by cottage industries and serves as a primary source of income for rural populations (Hutami et al., 2023). However, at the small-scale industry level, business management still faces various constraints, specifically regarding hygiene, quality standardization, and packaging (Aprieni et al., 2024). These limitations in production hygiene and quality standards mean that products often fail to meet the requirements of modern markets (Aprieni et al., 2024; Rustamsyah et al., 2022). Furthermore, uninspired packaging and the lack of quality standards contribute to the low added value of palm sugar products at the producer level (Wicaksana et al., 2024).

Sungai Ular Village is a region with significant potential in palm sugar resources, possessing more than 350 productive trees scattered across community plantations. Despite this potential, these resources have not been fully optimized to increase production capacity or improve community welfare (Siregar et al., 2025). Palm sugar production at the household level in this village is generally a side business, utilizing manual methods and simple packaging without standardized labels to establish a clear product identity (Radam & Rezekiah, 2015). These conditions result in relatively low selling prices and make it difficult to enter modern markets, thereby limiting marketing access to a broader audience. Furthermore, the implementation of sanitation and microorganism contamination control remains suboptimal, affecting food safety, quality stability during storage, and product shelf life (Dewita et al., 2025). A lack of literacy in processing technology and digital marketing also restricts business expansion (Siregar et al., 2025).

From an economic development perspective, strengthening micro, small, and medium enterprises (MSMEs) is a vital strategy for improving the welfare of rural communities. MSMEs have proven to contribute significantly to job creation and local economic growth, particularly in the natural resource-

based agro-industrial sector (Juanda et al., 2023; Nissa et al., 2025). The empowerment of MSMEs also plays a role in strengthening the community's economic structure through the utilization of local potential and the development of community-based entrepreneurship (Siregar et al., 2025). Therefore, efforts to improve production quality and business management are strategic steps to strengthen the competitiveness of local products in wider markets.

This situation underscores the importance of strengthening palm sugar-based MSMEs as a driver of the local economy. MSMEs play a strategic role in absorbing labor and utilizing local natural resources (Nissa et al., 2025). Strengthening this sector aligns with Sustainable Development Goals, particularly poverty alleviation (SDG 1), decent work and economic growth (SDG 8), and responsible consumption and production (SDG 12). However, increasing productivity and quality is a prerequisite for products to meet national food standards and compete effectively on a broader scale (Rustamsyah et al., 2022).

One approach to enhancing MSME capacity is through integrated training programs focused on production quality standards. The Indonesian National Standard (SNI) for palm sugar provides guidelines for hygienic processing, raw material quality control, and packaging techniques that comply with food safety standards (Rustamsyah et al., 2022). Transitioning from traditional production to a standardized system requires comprehensive training. In this context, SNI 3743:2021 serves as a vital reference for improving palm sugar quality. Training focuses on the application of appropriate technology such as sap filtration, efficient heating techniques, and hygienic drying, as well as industrial sanitation, standardized packaging, and quality control during production (Meikapasa et al., 2025b). These efforts not only improve product quality and shelf life but also strengthen consumer trust (Hosseini & Pouratashi, 2011). Furthermore, process innovations like controlled cooking temperatures and hygienic drying can enhance the physicochemical properties and extend the storage stability of the product (Meikapasa et al., 2025b). Strengthening the competency of producers through education and training has also been proven to improve entrepreneurial skills and business management effectiveness (Hosseini & Pouratashi, 2011).

In addition to production aspects, the digitalization of MSMEs has become a crucial strategy for expanding market access (Bahasoan et al., 2024). Beyond improving production quality, digital transformation is a vital factor in supporting MSME growth within the digital economy era. Utilizing digital technologies, including e-commerce platforms, social media, and online marketplaces, provides opportunities for producers to broaden their marketing networks, expand distribution reach, and enhance product visibility (Bahasoan et al., 2024; Cahyadi & Pradnyani, 2022). Digitalization also enables greater operational efficiency through transaction recording systems, inventory management, and the integration of electronic payment systems (Harahap et al., 2021; Mendrofa et al., 2025; Purba et al., 2023). For products based on local wisdom, such as palm sugar, these digital marketing strategies can be combined with strengthening a unique product identity and innovative packaging to increase added value and consumer appeal (Mendrofa et al., 2025; Wicaksana et al., 2024).

The development strategy for palm sugar MSMEs must be implemented in an integrated and sustainable manner, covering quality improvement, packaging innovation, product diversification, and strengthened business management (Wahyuni & Fiddin, 2024). Product diversification, such as palm sugar granules (gula semut) or palm syrup, results in physicochemical and organoleptic characteristics that are influenced by the specific production methods used (Meikapasa et al., 2025b). Ultimately, the development of palm sugar MSMEs requires an integrated approach involving various stakeholders. Collaboration between village and local governments, universities, and the community is a key factor in creating a conducive and sustainable business ecosystem (Nugroho & Andarini, 2020; Widodo et al., 2024). Through a community empowerment approach based on local potential, development programs can be designed according to the needs and characteristics of the region, making them more effective in increasing the community's business capacity.

This community service program aims to accelerate the capacity building of palm sugar MSMEs by implementing production quality standards, utilizing appropriate technologies, and developing digital marketing strategies. The implementation team focuses on increasing production capacity and restructuring the packaging system to ensure that products meet national standards and possess a more competitive brand identity. These efforts encourage palm sugar MSMEs in Sungai Ular Village to grow as independent, adaptive, and sustainable enterprises while providing a tangible contribution to improving rural welfare and strengthening the national agribusiness sector. Based on this background, the objective of this community service program is to bolster the capacity of palm sugar MSMEs by enhancing production quality, applying appropriate technology, and developing digital marketing strategies. These initiatives are expected to increase product added value, broaden market access, and foster sustainable economic independence for rural communities (Juanda et al., 2023; Wahyuni & Fiddin, 2024).

## **2. METHODS**

This community service program involves the Sungai Ular Palm Sugar Business Group as the primary project partner. The group consists of 10 active artisans who manage household-scale palm sugar processing businesses in Sungai Ular Village, Secanggang District, Langkat Regency, North Sumatra Province. Local village officials support these activities by providing training facilities and assisting with participant coordination throughout the program.

The execution team employs a participatory approach across the entire sequence of activities. The team engages partners to identify production and marketing obstacles through initial discussions. During these sessions, partners indicated that the production process still relies on basic iron-based equipment, has yet to implement quality standards, and does not fully utilize digital marketing. Based on these identified needs, the team then formulated a targeted intervention plan.

The team implemented the *Teknologi Tepat Guna* (TTG) or appropriate technology concept to enhance production quality without drastically altering the scale of operations. Conventional production tools were replaced with food-grade stainless steel equipment to minimize contamination risks and maintain consistent product coloration. Partners utilized Type 304 stainless steel pans, filters, stirrers, and food-grade molds during the cooking and molding stages. Additionally, the team introduced refractometers to measure sugar content and pH meters to monitor the acidity of the sap prior to heating. The application of these instruments assists partners in performing simple yet measurable quality control in accordance with SNI 3743:2021 principles.

Technical training was conducted through interactive lectures, demonstrations, and hands-on practice. Participants studied sap filtration techniques, cooking temperature regulation, granulated sugar drying methods, and sanitation procedures for both equipment and production areas. The team mentored participants during trial production runs to ensure each stage was performed consistently. This mentorship encourages participants to understand the direct correlation between processing techniques and final product quality.

Digital marketing strategies were also integrated as part of the business strengthening process. Partners utilize WhatsApp for promotion through status updates, broadcast messages, and dedicated groups. Furthermore, an Instagram account was created to showcase product catalogs and establish communication with potential buyers. The team plans for subsequent marketing through online marketplaces to broaden distribution networks. This digital strategy helps partners increase product visibility and expand market access beyond the village boundaries.

The team conducted the program from September to December 2025 through several structured stages. Activities began in early September 2025 with socialization and problem identification, while simultaneously measuring the partners' initial knowledge levels. The team then proceeded with technical training and the implementation of appropriate technology from mid to late September 2025. Production mentoring and the strengthening of digital marketing occurred throughout October and November 2025. The team concluded the project in December 2025 with monitoring and evaluation, involving post-test knowledge assessments and product quality observations.

This sequence of methods ensures that the activities not only enhance the technical skills of the partners but also strengthen their managerial and marketing capacities. This approach encourages partners to apply quality standards consistently and develop their palm sugar businesses with greater independence.

### 3. RESULTS AND DISCUSSION

#### Results

The training and mentorship programs resulted in significant changes in both product quality and the business capacity of the partners. Based on physicochemical analysis of palm sugar samples conducted before and after the educational activities, clear differences were observed in the color parameters and the level of product clarity.

**Table 1.** Physicochemical analysis before education (before training)

Before Training	L*	a*	b*	b*/a*	C*	h*	YI
1	19.61	5.38	4.73	0.88	7.17	65.20	34.45
2	18.22	4.88	2.83	0.58	5.64	98.68	22.22
3	15.06	5.39	5.45	1.01	7.66	56.69	51.67
<b>Average</b>	<b>17.63</b>	<b>5.22</b>	<b>4.34</b>	<b>0.82</b>	<b>6.82</b>	<b>73.53</b>	<b>36.11</b>

**Table 2.** Physicochemical analysis after education (after training)

After Training	L*	a*	b*	b*/a*	C*	h*	YI
1	24.96	5.91	5.09	0.86	7.80	66.56	29.13
2	25.83	6.31	4.91	0.78	8.00	73.63	27.15
3	23.90	6.30	7.24	1.15	9.60	49.85	43.28
Average	24.90	6.17	5.75	0.93	8.46	63.35	33.19

Based on the physicochemical color test results in Table 1 and Table 2, a notable improvement in the visual quality of the palm sugar occurred after the training. The chroma value (C\*) increased from 6.82 to 8.46, indicating enhanced clarity and color intensity in the post-training production. This rise suggests a superior visual quality and a higher level of color purity. The Yellowness Index (YI) decreased from 36.11 to 33.19, signifying that the cooking process became more controlled and the risk of scorching was reduced following the adoption of stainless-steel equipment and improved temperature management. Visually, the resulting palm sugar appeared brighter, clearer, and more uniform, with more stable color intensity consistent with high-quality palm sugar characteristics.

**Farmer empowerment through training on palm sugar standardization in Eastern Coastal Region of North Sumatera**

*Dolly Sojuangan Siregar, Rosmayati, Rahmat Suryanto Pirngadi, Anggreiny*

Meanwhile, the hue value (h\*), which defines the specific color category or tint, remained relatively stable. This stability indicates consistent product tones after the production improvements were implemented.

**Table 3.** Physiochemical analysis of water content

<b>Sample Name</b>	<b>Cup Weight (g) W0</b>	<b>Sample Weight (g)</b>	<b>Constant Weight (g) W2</b>	<b>Weight of Cup + Sample (W1)</b>	<b>Water Content (%)</b>
<i>Gula Baru 1</i>	4.9328	20.0008	22.6894	24.9336	11.2206
<i>Gula Baru 2</i>	5.0647	20.0001	22.6816	25.0648	11.9159
<i>Gula Baru 3</i>	5.0723	20.0006	22.8520	25.0729	11.1042
<i>Gula Lama 1</i>	5.0609	20.0005	22.0245	25.0614	15.1841
<i>Gula Lama 2</i>	5.0609	20.0002	22.0543	25.0611	15.0338
<i>Gula Lama 3</i>	5.0609	20.0005	22.0145	25.0614	15.2341
<i>Gula Semut 1</i>	5.2152	20.0002	24.2055	25.2154	5.0494
<i>Gula Semut 2</i>	4.9392	20.0007	23.9186	24.9399	5.1063
<i>Gula Semut 3</i>	4.9927	20.0001	24.0124	24.9928	4.9020

**Table 4.** Physiochemical analysis of ash content

<b>Sample Name</b>	<b>Cup Weight (W0)</b>	<b>Sample Weight (g)</b>	<b>Final Sample Weight (W2)</b>	<b>Sample Weight + Cup Weight (W1)</b>	<b>Ash Content (%)</b>
<i>Gula Baru 1</i>	36.65	5.00	36.78	41.65	2.53
<i>Gula Baru 2</i>	35.23	5.00	35.36	40.23	2.57
<i>Gula Lama</i>	39.05	5.00	39.18	44.05	2.64

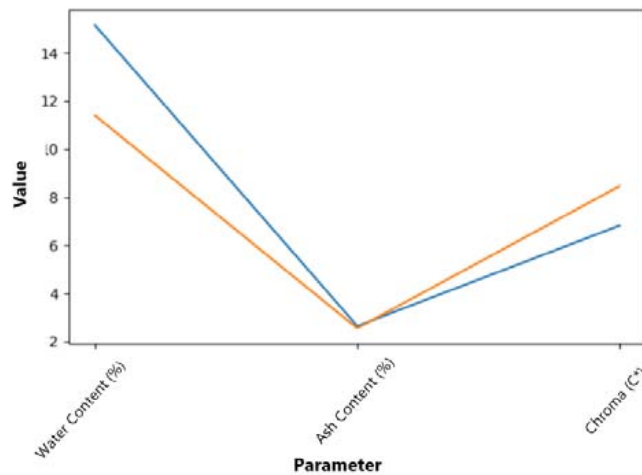
Moisture content is a critical parameter in palm sugar quality because it influences shelf life and the risk of fermentation. As illustrated in Table 3, the moisture content of the previous palm sugar products was approximately 15 percent, whereas the post-training samples decreased to approximately 11 percent. This value closely approaches the maximum limit established by the Indonesian National Standard (SNI), which is 10 percent. For granulated palm sugar products, the moisture content ranged between 4.9 percent and 5.1 percent, indicating full compliance with SNI standards.

Ash content serves as an indicator of the inorganic residue remaining after the combustion of organic matter within a sample. This value reflects the level of purity and the potential for mineral contamination in food products, including palm sugar. The Indonesian National Standard (SNI 01-3743-1995) sets the maximum ash content for brown sugar at 2.5 percent. Regarding the ash content parameter in Table 4, the new sugar samples ranged between 2.53 percent and 2.57 percent, which is very close to the 2.5 percent SNI threshold. Although not yet entirely perfect, these results demonstrate significant improvement compared to previous products.

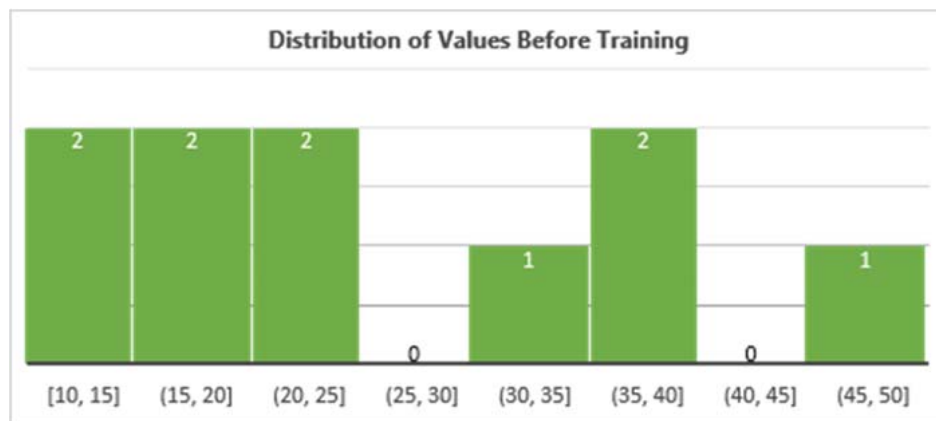
Physicochemical analysis indicates that the community service program (PKM) exerted a positive impact on the quality of the palm sugar products. Figure 1 illustrates the comparison of product quality before and after the training sessions. The moisture content decreased from 15.15 percent to 11.40 percent, suggesting that the cooking and drying processes were more optimized, resulting in improved product stability and shelf life. The ash content declined from 2.64 percent to 2.55 percent, indicating improvements in raw material cleanliness and production hygiene.

Furthermore, the chroma value (C\*) rose from 6.82 to 8.46, reflecting a brighter and more uniform product color due to more stable temperature control during the cooking phase. The shifts in these three parameters confirm that the application of appropriate technology and standardized production processes contributed to a measurable enhancement in palm sugar quality. Overall, the quality assessment results show that the palm sugar and granulated sugar produced after the training closely approach or, in some cases, fully meet the Indonesian National Standard (SNI 3743:2021), serving as an indicator that the technical intervention was effective.

**Comparison of Product Quality Before and After the Community Service**



**Figure 1.** Comparison of physiochemical parameters of palm sugar before and after the community service program

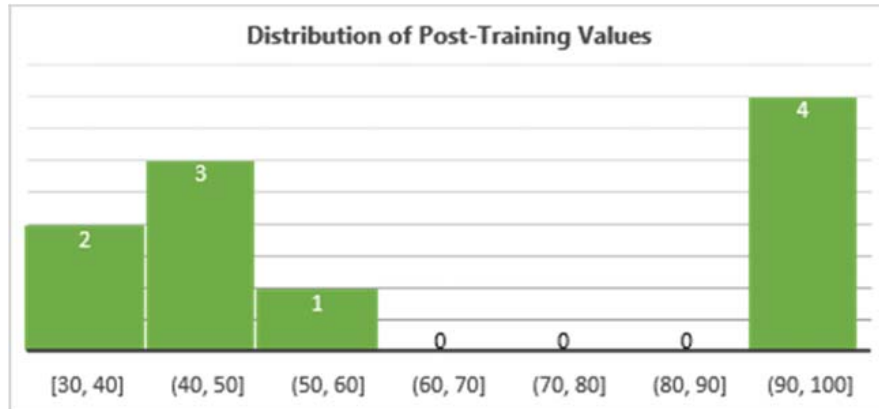


**Figure 2.** Distribution graph of values before training

The team measured participant skills using pre-test and post-test instruments covering hygienic production, quality control, and digital marketing. The evaluation results, as shown in Figure 2 and Figure 3, along with the comparison in Table 5, revealed a substantial effect size (Cohen's  $d = 1.17$ ). The mean score rose from 27.50 before the training to 66.00 afterward. This mean difference of 38.50 points indicates a significant competency improvement following the program.

**Farmer empowerment through training on palm sugar standardization in Eastern Coastal Region of North Sumatera**

*Dolly Sojuangan Siregar, Rosmayati, Rahmat Suryanto Pirngadi, Anggreiny*



**Figure 3.** Post-training value distribution graph

**Table 5.** Comparison of skill scores and competency categories of participants before and after training

Statistical Parameters	Before Training (Pre-test)	After Training (Post-test)
Average Score	27.50	66.00
Standard Deviation (SD)	13.38	30.07
Value Range	10.50	30–100
Average Difference	–	38.50
Competency Category*	Low–Basic	Fair–Good

Category description (score interpretation): 0–40 = Low, 41–60 = Basic/Fair, 61–80 = Good, 81–100 = Very Good.

The score range also shifted from 10–50 to 30–100, signaling that most participants achieved a higher level of understanding. Based on categorical interpretation, participant competency transitioned from a Low-Basic level to a Fair-Good level. This shift demonstrates that the training not only enhanced theoretical knowledge but also strengthened practical abilities in standardized palm sugar production. These results confirm that a participatory training approach combined with appropriate technology can serve as an efficient strategy for empowering rural communities to develop value-added agricultural products. Specifically, the pre-training mean score was  $27.50 \pm 13.38$  (range 10–50), which increased to  $66.00 \pm 30.07$  (range 30–100) after the program. The average gain of 38.5 points reflects a considerable transformation in participant capabilities.



**Figure 4.** Packaging design of “Gula Aren Sungai Ular” and derivative products processed from palm sugar

The design consensus reached following discussions with the Sungai Ular Palm Sugar Group resulted in packaging innovations for "Gula Aren Sungai Ular" and "Gula Semut Sungai Ular," which integrate traditional Langkat Malay ethnic elements with a modern minimalist aesthetic. The establishment of this distinct brand identity and Langkat Malay-themed packaging, as shown in Figure 4, represents a pivotal step in developing MSMEs that transition from mere production to operating as independent, market-oriented enterprises.

The team observed that labeled packaging and a clearer brand identity significantly bolster consumer confidence. Consumers demonstrated higher interest in products that transparently display ingredient information and production dates. This situation illustrates a direct correlation between improved product visual quality and sales growth.

## **Discussion**

This program integrates three primary approaches: (1) Improving production processes; (2) Strengthening basic quality control at the household level; and (3) Developing a digital marketing-based brand identity. This integrated framework differs from most MSME empowerment programs, which typically focus on short-term technical training without subsequent assistance. This program extends the mentorship process to include packaging design improvements, facilitation of business legality (such as PIRT and Halal certification), and the formulation of online promotion strategies via digital platforms. Such an approach addresses the entire business value chain, ensuring that the resulting changes are comprehensive and sustainable. The integration of these various aspects allows for transformation not only in production processes but also in the overall business system, thereby creating the potential for sustainable enterprises based on local resources (Aprieni et al., 2024; Gobel et al., 2023; Juanda et al., 2023).

The improvement in participants' skills, as reflected by the increase in training evaluation scores, aligns with the changes in production practices at the partner level. Following the mentorship activities, producers began utilizing stainless steel equipment which is safer for food contact to maintaining more consistent temperature control during sap boiling, and upholding hygiene throughout every production stage. Additionally, the implementation team introduced digital scales and refractometers as simplified quality control tools. The application of such appropriate technology has been proven to enhance product consistency and reduce quality variation in small-scale food enterprises (Radam & Rezekiah, 2015; Rustamsyah et al., 2022; Widodo et al., 2024). These technical shifts resulted in molded palm sugar and palm sugar granules with a more uniform texture, stable color, and improved density compared to the period prior to the program intervention.

These findings are consistent with reports on food MSME empowerment, indicating that the implementation of process standardization and the use of more hygienic equipment can enhance product quality while simultaneously strengthening consumer trust (Setiawan, 2020; Suri et al., 2024; Wicaksana et al., 2024). Beyond the technical aspects of production, this program emphasizes the importance of product innovation and the diversification of sap-based derivatives. Developing products such as palm sugar granules (gula semut) and palm syrup provides added economic value and expands market opportunities. Variations in sap-based products are known to possess distinct physicochemical and organoleptic characteristics depending on the processing methods employed (Dewita et al., 2025; Meikapasa et al., 2025b). Therefore, improving production skills is a critical factor in maintaining the quality consistency of these processed products.

## Farmer empowerment through training on palm sugar standardization in Eastern Coastal Region of North Sumatera

*Dolly Sojuangan Siregar, Rosmayati, Rahmat Suryanto Pirngadi, Anggreiny*

Furthermore, this program demonstrates added value through the integration of technical training with digital-based marketing strategies. Partners utilized WhatsApp, Instagram, and marketplaces for promotion and transaction recording. This strategy accelerated the increase in sales volume and expanded consumer networks beyond the village boundaries. This transformation indicates a shift from conventional marketing patterns toward a digital marketing model that is more adaptive to market developments. Business digitalization has been proven to broaden consumer reach, improve operational efficiency, and strengthen MSME competitiveness in an increasingly open market (Harahap et al., 2021; Mendrofa et al., 2025; Purba et al., 2023). Strengthening digital-based marketing strategies also enables producers to build a stronger brand identity and expand distribution networks beyond their local area (Nugroho & Andarini, 2020; Wahyuni & Fiddin, 2024).

From a community empowerment perspective, this program drives transformation by shifting traditional production patterns toward a more professional and organized micro-business model. Indicators of success are reflected not only in increased training evaluation scores but also in higher selling prices, growth in production volume, and the partners' ability to conduct independent quality control. There has been a notable shift in business behavior among partners, encompassing production recording, product quality management, and more active communication with consumers. This mentorship process has proven essential in building the entrepreneurial capacity of rural communities, enabling local resource-based enterprises to develop more independently (Bahasoan et al., 2024; Hosseini & Pouratashi, 2011; Hutami et al., 2023). This transformation strengthens the foundation of business independence based on local potential.

Overall, the impact of the program can be observed across three primary aspects. First, the quality of molded palm sugar and palm sugar granules now aligns more closely with national standards through the implementation of hygienic and standardized production processes, as evidenced by improvements in physicochemical parameters. Second, business competitiveness has increased through production efficiency and the utilization of broader digital marketing strategies. Third, the partners' entrepreneurial capacity has evolved through enhanced knowledge of business management, brand identity, and the ability to build consumer relations, providing a solid foundation for sustainable growth. The combination of technical training, hands-on practice, and intensive mentorship has proven effective in establishing a model of village entrepreneurship that is connected to the market, or market-linked entrepreneurship (Cahyadi & Pradnyani, 2022; Nissa et al., 2025; Siregar et al., 2025).



**Figure 5.** The sequence of socialization activities and technical training for palm sugar processing at the Sungai Ular Village Hall

Figure 5 illustrates the implementation of the socialization phase through discussions and material presentations to village officials and the business group, followed by technical training on hygienic production and quality standardization. The image depicts demonstrations on the use of stainless steel

equipment, sugar molds, and the provision of appropriate technology (AT) as part of the efforts to improve product quality in alignment with SNI. These activities serve as the foundation for production mentoring, participant skill evaluations, and institutional strengthening to guide the "Aren Sungai Ular" MSME toward business independence.



**Figure 6.** The process of processing and printing palm sugar as a superior product of Sungai Ular Village

Figure 6 illustrates the production stages, starting from the boiling of sap in the furnace and the stirring process until reaching the correct consistency, through to the molding and cooling of the palm sugar blocks. This activity is part of the production mentorship conducted over two months to ensure the consistent application of hygienic techniques, temperature control, and quality standards.

Through pre-test and post-test evaluations, there was an average increase in participant skills of 80 percent, which is reflected in products that are more uniform, dense, and possess more stable coloration. This documentation also demonstrates the transformation of the production process toward a more standardized system, ready to be developed as a premium village product with food-grade packaging and a local brand identity.

Figure 7 displays the final stage of granulated palm sugar production, starting from the stirring process until dry, loose, and uniform granules are formed. The more controlled drying process results in a fine texture without clumps and a natural brown color that appears more stable. The product is then packaged using food-grade standing pouches labeled "Gula Aren Sungai Ular," making it appear neater, more informative, and ready to be marketed more professionally.

In addition to granulated sugar, this figure also shows the development of a derivative product in the form of palm sugar syrup. It illustrates the sap cooking process until the desired thickness is achieved, stirring to maintain consistency, and filtering to reduce impurities and sediment before being hygienically packaged. This syrup is designed as a value-added variant with a distinct flavor profile, a clearer appearance, and a stable thick texture. The use of food-grade labeled bottle packaging is not only enhances product appeal but also extends shelf life and facilitates more efficient distribution.

## Farmer empowerment through training on palm sugar standardization in Eastern Coastal Region of North Sumatera

Dolly Sojuangan Siregar, Rosmayati, Rahmat Suryanto Pirngadi, Anggreiny

Furthermore, product diversification and updated packaging strengthen the business identity, positioning it as a premium village product that is increasingly prepared to compete in broader markets (Meikapasa et al., 2025a; Simamora, 2022).



**Figure 7.** Processing results and finishing of derivative products as training outputs

#### 4. CONCLUSION AND RECOMMENDATIONS

This community service program successfully achieved its primary objective: enhancing the economic independence of the Sungai Ular Village community through standardization and capacity building of the palm sugar business. The team implemented technical training based on SNI 3743:2021 and applied appropriate technology, resulting in an 80 percent improvement in participant skills. Partners are now capable of producing more hygienic, standardized, and modernly packaged products supported by PIRT legality. The program also strengthened business competitiveness through marketing digitalization and product diversification, specifically granulated sugar and palm syrup. These changes have increased the partners' bargaining position in the regional market while establishing a more professional business foundation. Overall, the integration of technical training, sustainable mentorship, and the optimization of local potential has proven effective in driving the transformation of rural agro-industry-based MSMEs. To ensure the sustainability of this impact, the program recommends institutional strengthening through the formation of production cooperatives, the expansion of digital marketing networks, and collaborative follow-up research to develop high-value-added palm derivative products.

Recommendations for future program implementation include the need to expand product legality facilitation through Halal certification and "Makanan Dalam" (MD) distribution permits, enabling broader access to modern retail markets. Subsequent programs are also encouraged to develop research-based product diversification, such as palm syrup and flavored granulated sugar variants, to increase added value and expand market segments. Furthermore, the implementing team should encourage the establishment of business institutions, such as producer cooperatives, to strengthen raw material management, capital access, and collective business sustainability.

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## Farmer empowerment through training on palm sugar standardization in Eastern Coastal Region of North Sumatera

Dolly Sojuangan Siregar, Rosmayati, Rahmat Suryanto Pirngadi, Anggreiny

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