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Palm-based business development at Al Hidayah Islamic Boarding School in Sei Mencirim Village, Kutalimbaru Sub-District, Deli Serdang District

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ABSTRACT

Al Hidayah Islamic Boarding School in Kutalimbaru District is an independent educational institution that offers free education to its students. Its operational funding is supported by a business unit that processes palm sap into molded palm sugar, liquid palm sugar, palm sugar crystals, and other palm-based products such as candied palm fruit. However, the production methods used are still traditional and depend on simple tools, which often lead to variations in product quality. This community service program was designed to enhance productivity and improve the quality of palm sap products through the introduction of modern processing technology. The program consisted of seven phases: socialization, preparation of tools and materials, training, provision of equipment and technology, technology implementation, mentoring and evaluation, and ensuring sustainability. Participants included pesantren leaders, teachers, and students. The technologies introduced such as sap cooking machines, drying ovens, and sieving equipment—significantly improved efficiency. The sap cooking machine reduced processing time to about 2 hours, compared to the traditional 4–6 hours. The resulting molded, liquid, and crystal palm sugar products exhibited better and more consistent quality. Participants have also gained the necessary knowledge and skills to apply these innovations independently.
Keyword: Palm; Moulded Palm Sugar; Powder Palm Sugar; Sap; Pesantren Al Hidayah

ABSTRAK

Pondok Pesantren Al Hidayah di Kecamatan Kutalimbaru merupakan lembaga pendidikan mandiri yang menyediakan pendidikan gratis bagi para santrinya. Dana operasionalnya didukung oleh unit usaha yang mengolah nira aren menjadi gula aren cetak, gula aren cair, kristal gula aren, dan produk berbasis aren lainnya seperti manisan buah aren. Namun, metode produksi yang digunakan masih tradisional dan bergantung pada peralatan sederhana, yang seringkali menyebabkan variasi kualitas produk. Program pengabdian masyarakat ini dirancang untuk meningkatkan produktivitas dan kualitas produk nira aren melalui pengenalan teknologi pengolahan modern. Program ini terdiri dari tujuh tahap: sosialisasi, penyiapan alat dan bahan, pelatihan, penyediaan peralatan dan teknologi, implementasi teknologi, pendampingan dan evaluasi, serta memastikan keberlanjutan. Pesertanya meliputi pimpinan pesantren, guru, dan santri. Teknologi yang diperkenalkan seperti mesin pemasak nira, oven pengering, dan peralatan pengayak, secara signifikan meningkatkan efisiensi pengolahan nira. Mesin pemasak nira mengurangi waktu pemrosesan menjadi sekitar 2 jam, dibandingkan dengan waktu pemrosesan tradisional yang 4–6 jam. Produk gula aren cetak, cair, dan kristal yang dihasilkan menunjukkan kualitas yang lebih baik dan lebih konsisten. Para peserta juga memperoleh pengetahuan dan keterampilan yang diperlukan untuk menerapkan inovasi ini secara mandiri.
Keyword: Aren, Gula Merah; Gula Semut;Nira; Pesantren Al Hidayah

1. Introduction

Al-Hidayah Islamic Boarding School operates under the Al-Ghazali Foundation of North Sumatra, established by Ustadz Khairul Ghazali on July 1, 2015. The foundation, located in Dusun IV, Sei Mencirim Village, Kutalimbaru Sub-district, Deli Serdang Regency, North Sumatra, is engaged in the fields of education, social welfare, and religious outreach (da'wah). The school provides free education for all students; however, it receives only limited financial assistance from the government, primarily in the form of School Operational Assistance (BOS) such as textbook support. To sustain its educational activities, including teacher salaries, student meals, and other operational costs, the foundation has initiated several income-generating ventures.

One of the main enterprises developed by Al-Hidayah is a sugar palm (Arenga pinnata)-based business, positioning the institution as a Palm-Based Islamic Boarding School. The enterprise encompasses the cultivation and sale of sugar palm seedlings as well as the processing of sugar palm products, including molded palm sugar, palm sugar granules, liquid palm sugar, sugar palm fruit (kolang-kaling), and various derivative products such as palm sugar coffee and palm sugar chili paste. Despite its potential, the production process remains highly traditional, utilizing non-standard facilities that do not comply with Good Processed Food Production Practices or Good Manufacturing Parctice (GMP) and relying on rudimentary equipment. Consequently, productivity levels are low, and product quality lacks consistency and uniformity.

The boarding school has previously received support from lecturers at the Faculty of Agriculture, Universitas Sumatera Utara (USU), particularly in sugar palm seedling cultivation and in the integration of palm cultivation with livestock and aquaculture systems. The surrounding area includes abandoned sand excavation sites (C-excavation areas) that require ecological rehabilitation, and collaborative efforts with USU have focused on utilizing these degraded lands for sugar palm cultivation. Discussions with Ustadz Khairul Ghazali, the school's head, revealed that further technical assistance is needed to enhance both cultivation and product processing. Therefore, this community engagement program aims to strengthen the capacity of the school in managing and developing its sugar palm–based enterprise.

An analysis of the existing situation and discussions with the partner institution identified two major areas of concern: production and processing, and management and marketing. From the production perspective, the primary issue lies in the inadequacy of the processing facilities, which have not yet met the required standards for food production. The equipment used in processing remains basic, relying primarily on wood-fueled stoves and large pans for boiling sugar sap. Although this approach is cost-effective due to the easy availability of firewood in the surrounding area, it poses significant environmental and health challenges because of the air pollution generated. This practice contradicts the principles of the Green Economy currently being promoted globally. Traditional cooking practices (TCP) that use solid fuels contribute substantially to indoor air pollution, which is associated with approximately 4.3 million deaths annually worldwide [1]. Beyond health impacts, such practices accelerate deforestation and forest degradation and are recognized as major sources of black carbon and carbon dioxide emissions that contribute to climate change [2], [3], [4]. Hence, upgrading the production facilities and adopting cleaner, energy-efficient processing technologies are necessary to support sustainable production.

The use of non-standard and inefficient processing equipment also affects product quality, leading to outcomes such as high moisture content, dark coloration, and product contamination [5]. Low-quality palm sugar granules have limited market opportunities, especially in modern retail sectors. The dark color often results from overheating, which induces excessive caramelization during processing [6]. Furthermore, inadequate sanitation in production areas increases the risk of foodborne contamination. Ensuring food safety is therefore a critical concern, as contaminated food can create a continuous cycle of illness. Considering the potential transmission of diseases through contaminated food and beverages, maintaining proper hygiene and sanitation during food handling and processing is a vital component of public health and community well-being [7].

This community engagement initiative is thus designed to enhance the overall capacity of Al-Hidayah Islamic Boarding School in sustainable agro-processing. The program aims to improve production efficiency and product quality through facility upgrades in compliance with Good Manufacturing Practices (GMP) for Processed Food principles and the introduction of more hygienic and efficient sap-processing equipment. Furthermore, it seeks to reduce dependence on traditional wood-fueled cooking practices by promoting clean energy–based processing technologies aligned with Green Economy principles, thereby minimizing air

pollution and environmental degradation. The initiative also emphasizes strengthening food safety and product consistency, particularly for palm sugar granules and their derivatives, through improved sanitation practices and the application of hygienic processing procedures to meet modern market standards. Finally, the program intends to build the school's managerial and marketing capacity through social entrepreneurship development, enabling the sugar palm enterprise to evolve into a sustainable, self-reliant business unit that supports the school's educational and religious missions.

2. Methods

The stages of the community service activities consist of seven phases, namely: socialization, preparation of tools and materials to be granted to the partners, training, provision of equipment and technology to the partners, technology implementation, mentoring and evaluation, and program sustainability, as presented in Figure 1.

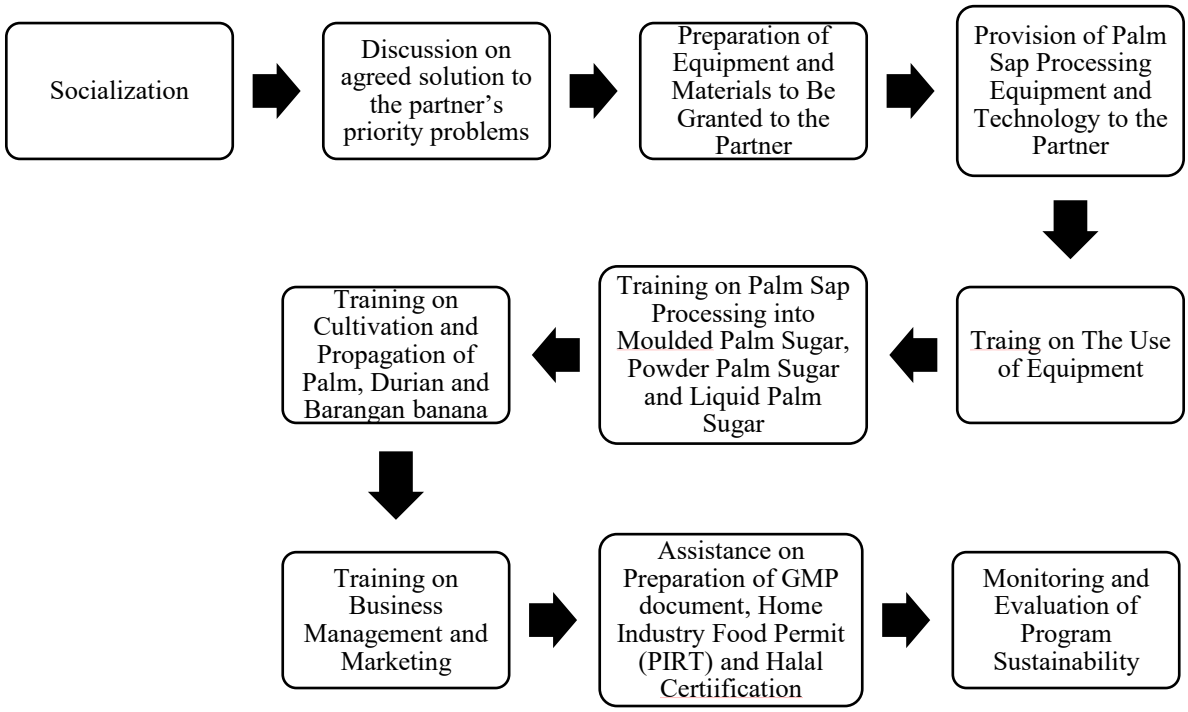

Figure 1. Method and stages of technology implementation provided to the partner.

2.1 Socialization and training

The community engagement program was implemented through an integrated approach combining theoretical education, hands-on practice, mentoring, and production facility enhancement. The activities began with interactive lectures and discussions on Good Manufacturing Practices (GMP) for Processed Food, followed by technical sessions on processing palm sap into various value-added products such as molded palm sugar, palm sugar powder, and liquid palm sugar. Additional topics included packaging selection, determination of product shelf life and quality, cultivation and propagation of palm and fruit trees, as well as business management and marketing strategies. This interactive approach was designed to enhance participants' understanding through two-way communication and to ensure measurable learning outcomes.

2.2 Provision of equipment and processing technology

To strengthen business sustainability and productivity, the partner institution, Al Hidayah Islamic Boarding School, received a set of appropriate processing technologies, including a palm sugar mixer, a drying oven for palm sugar powder, milling and sieving equipment, a packaging sealer, a mechanical bottle capper, and product packaging and labeling materials. These tools were intended to improve product quality, hygiene, and production efficiency in accordance with GMP standards.

2.3 . Practical implementation of processing technologie

Following the training and equipment handover, participants conducted hands-on practice in processing molded palm sugar, palm sugar powder, and liquid palm sugar using the newly provided technologies. This phase aimed to strengthen technical competence and ensure that participants were able to apply the acquired knowledge effectively in real production settings.

2.4 Mentoring, monitoring, and evaluation

Regular mentoring and monitoring sessions were conducted to assess the partners' ability to adopt the introduced technologies and to identify potential challenges encountered in the field. The final evaluation involved interviews and direct observations to measure the effectiveness of the program in improving production capacity, product quality, and business management. The active participation of the partner institution—in providing training facilities, preparing raw materials (palm sap and palm seeds), and committing to the adoption of introduced technologies—demonstrated strong engagement and ownership toward sustaining and expanding palm-based product enterprises.

3. Results and Discussion

The implementation of the community service program at Pesantren Al Hidayah, located in Sei Mencirim Village, Kutalimbaru Subdistrict, Deli Serdang Regency, included several stages: activity socialization, preparation of equipment to be granted to the partner, delivery of the equipment, training on the use of the provided tools and technologies, implementation of appropriate technology, as well as evaluation and monitoring of the program's sustainability.

3.1. Socialization and training

The socialization activities, along with the identification of problems and formulation of solutions offered to the partner, had been conducted prior to the proposal submission. After the proposal was approved for funding, the team resumed discussions and coordination with the partner regarding the planned activities and the proposed solutions to address the partner's challenges, particularly in the areas of production, processing, business management, and marketing. The socialization stage also involved university students who participated in coordinating the design and capacity of the appropriate technology equipment, as well as improving the layout of the palm sugar production room to meet the Good Manufacturing Practices (GMP) standards required by the Indonesian Food and Drug Authority (BPOM RI) (Figure 2). This training enhanced the knowledge and skills of the Al Hidayah Islamic Boarding School partners in processing palm sap in accordance with Good Manufacturing Practices (GMP). Training on the implementation of GMP in the processing of palm sap and coconut sap into palm sugar and palm sugar crystals has also been carried out in community service activities in Wonosobo Village, Central Java [8], Sanggang Village, Central Java [9], and Kekait Village, West Lombok [10], and the results similarly demonstrated improvements in partner skills and the quality of the palm sugar products.

Figure 2. Students coordinating with the Head of Al Hidayah Islamic Boarding School regarding the appropriate technology equipment to be granted and the improvement of the production room layout.

To comply with Good Manufacturing Practices (GMP) standards, the partner improved the production area, which was previously a simple kitchen with an earthen floor, into a permanent production room with tiled flooring and brick walls. The renovation process of the production facility is shown in Figure 3. The production

room was designed to meet the facility standards stipulated in the Regulation of the Indonesian Food and Drug Authority (BPOM) No. 21 of 2021 concerning the Implementation of the Food Safety and Quality Assurance System. According to the regulation, the facility must be easy to clean, allow proper sanitation, be well-maintained, and prevent cross-contamination between products or contamination from the building structure. The production facility must also include adequate areas and facilities for receiving and loading operations [7].

Figure 3. The renovation process of the palm sugar production room (left) and the completed permanent production facility (right).

3.2. Provision of appropriate technology equipment for palm sap processing

The equipment granted to the partner included a palm sap cooking and stirring machine (Figure 4), a palm sugar powder drying oven (Figure 5), and a palm sugar sieving machine (Figure 6). The community service team collaborated with the "TTG" workshop in designing and fabricating the technology equipment provided to the partner. The specifications of the equipment are as follows:

1. Palm sugar cooking and crystallization machine:
   Function: To heat and process palm sap into sugar crystals.
   Dimensions: Length 650 mm, Width 650 mm, Height 1000 mm.
   Capacity: 20 liters per batch.
   Heating source: LPG stove.

Figure 4. Palm sap cooking and stirring machine.

2. Palm sugar powder drying oven:
   Material: Stainless steel casing.
   Dimensions (L × W × H): 60 cm × 60 cm × 70 cm.
   Features:

- Equipped with a temperature sensor for automatic temperature control.
- Digital timer (maximum 10-hour operation).
- Fully automatic heating system, eliminating manual gas stove use.
- Weight: 40 kg.
- Display panel for performance monitoring.
- Power: 50 W / 220 V (for sensor and blower operation).
- Equipped with an LPG gas leak detector.

Figure 5. Palm sugar powder drying oven.

3. Palm sugar sieving machine
   Function: To sieve palm sugar powder to obtain uniform particle size.
   Material: Stainless steel
   Power source: 220 V electric motor.
   Power consumption: 120 W
   Vibration frequency: 1000 N/min.
   Screen diameter: 400 mm.

Figure 6. Palm sugar sieving machine.

To increase production efficiency, many artisans have shifted to mechanical methods, where sap or sugar solution is heated using gas burners and stirred with motorized mixers. Various mechanical systems have been developed, including semi-horizontal drums [11], small-capacity crystallizers [12], and stainless-steel machines with motor-driven stirrers [13], all designed to improve heating efficiency, hygiene, and sugar granule quality.

3.3. Training and practice on the use of appropriate technology equipment

In addition to providing training on Good Manufacturing Practices (GMP) and business management, this activity emphasized the adoption of appropriate technology in palm sugar production. Traditionally, palm sap was cooked using a large wok heated with firewood, as shown in Figure 7a, whereas the cooking technology introduced in this community service program utilizes modern heating equipment, as presented in Figure 7b. The training was conducted through hands-on practice using the palm sap stirring and cooking machine, drying oven, grinder and sifter, packaging sealer, and mechanical bottle capper, all of which have now been operated by the partner to produce molded palm sugar, palm sugar powder, and liquid palm sugar.

(a) (b)

Figure 7. (a) Traditional firewood-based cooking of palm sap, (b) modern cooking technology introduced during the community service program.

The use of the stirring and cooking machine improved the homogeneity of heat distribution in palm sap, preventing excessive caramelization that could negatively affect product color quality. Heating palm sap triggers browning through the Maillard reaction [14], as the sap contains 16 types of amino acids that accelerate non-enzymatic browning [15]. The quality of palm sugar is strongly influenced by the heating process, which determines flavor development, sensory characteristics, and consumer acceptance. Among these, flavor is the most dominant quality attribute influencing consumer preference and consumption patterns. The levels of reducing sugars and sucrose in palm sugar also affect both the qualitative and quantitative sensory characteristics, including aroma and taste [16].

Furthermore, the use of the drying oven allowed for more stable temperature control compared to manual sun-drying, reducing product moisture content and producing palm sugar powder with a drier and crispier texture. The texture of palm sugar is highly dependent on moisture content, higher moisture results in softer sugar that more readily absorbs environmental humidity [11]. Packaging equipment, including sealers and mechanical cappers, also significantly enhanced food safety by minimizing post-production contamination. The BPOM RI [7], in its CPPOB guidelines, emphasizes that proper packaging serves not only as product protection but also as part of the overall sanitation system for food safety assurance.

The adoption of appropriate technology supports the transition from traditional production methods toward small- and medium-scale food industries that are more hygienic and environmentally friendly. The use of appropriate technology in community-based food enterprises is a key strategy to improve production efficiency, product consistency, and food safety while reducing energy waste and contamination risks. Therefore, the use of the donated equipment in this program represents a technological intervention that simultaneously supports the principles of the Green Economy and GMP.

3.4. Mentoring, monitoring, and evaluation

In this phase, the community service implementation team, together with participating students, provided mentoring on the application of the introduced appropriate technology and conducted evaluations of its implementation. The team also carried out regular monitoring to ensure program sustainability, confirming that the partner had successfully adopted the technology and was able to develop its business further. The evaluation was conducted in two stages. The first evaluation assessed whether the partner had applied the training outcomes in accordance with established standards. The second evaluation focused on monitoring

improvements in production output and the quality of palm sap-derived products. In the aspects of production and processing, the implementation of palm sap cooking machine, drying oven, and sieving machine, significantly improved production efficiency (Figure 8), productivity, product quantity, and quality at Pesantren Al Hidayah, Sei Mencirim Village, Kutalimbaru Subdistrict, Deli Serdang Regency (Table 1).

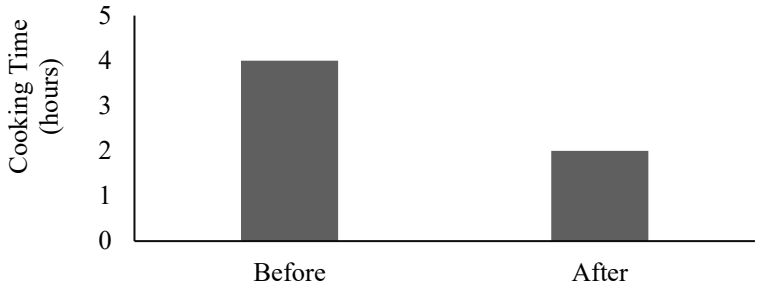

Figure 8. Graph of heating time efficiency for molded and powdered palm sugar production before and after implementation of appropriate technology for palm sap processing.

These findings are consistent with the outcomes of previous community service activities in Wonosobo, Sanggang, and Kekait, where the dissemination of appropriate technologies—particularly sap cooking units, drying ovens, and sieving systems—also resulted in increased production capacity, reduced moisture content in palm sugar products, and improved product uniformity. In those programs, partners demonstrated enhanced skills in implementing Good Manufacturing Practices (GMP), which directly contributed to higher-quality molded palm sugar and palm sugar powder. Similar to these earlier interventions, the technological integration in this program not only reduced processing time and labor requirements but also strengthened product hygiene, minimized contamination risks, and enhanced shelf life due to improved moisture control.

Table 1. Improvement in product quantity after the implementation of appropriate technology for palm sap processing at Al Hidayah Islamic Boarding School, Sei Mencirim Village, Kutalimbaru Subdistrict, Deli Serdang Regency.

Technology Innovation	Parameters	Before implementation of appropriate technology	After implementation of appropriate technology
Cooking Machine (Palm Sap Crystalization Machine)	Processing Time (hours)	6	1,5
	Processing Capacity of Palm Sap (kg/day)	40	60
	Production Capacity of Moulded Palm Sugar (kg/day)	8	12
	Production Capacity of Palm Sugar Powder (kg/day)	4	6
Palm Sugar Drying Oven	Drying Processing Time (hours)	6	2
Palm Sugar sieving machine	Particle Size of Palm Sugar Powder	Non-uniform	Uniform

The increase in product quantity was reflected in shorter processing times, higher production capacity, and greater output of molded, powdered, and liquid palm sugar (Figure 9). From the quality perspective, the produced palm sugar powder exhibited lower moisture content and more uniform particle size, resulting in a longer shelf life. In addition, the improved processing efficiency has enabled the partners to offer products at stable and competitive prices, with molded palm sugar sold at approximately Rp 25.000/kg, palm sugar powder at Rp 55.000/kg, and liquid palm sugar at Rp 60.000/kg. The products are currently distributed through

multiple channels, including online platforms, direct selling within the local community, and supply arrangements with hotels and restaurants, allowing broader market reach and increased economic impact.

Figure 9. Molded, powdered and liquid palm sugar produced by Pesantren Al Hidayah.

4. Conclusions

The provision of appropriate technology equipment for palm sugar processing consisting of a palm sap cooking machine, a drying oven, and a palm sugar sieving machine to Pesantren Al Hidayah, Sei Mencirim Village, Kutalimbaru Subdistrict, has significantly improved the productivity of palm-based products. The use of the palm sap cooking machine increased processing efficiency by reducing the cooking time to 2 hours, compared to 4–6 hours required by conventional methods. The resulting palm sugar products, including molded palm sugar, liquid palm sugar, and palm sugar powder, exhibited better and more uniform quality. The development of palm-based enterprises at Al Hidayah Islamic Boarding School serves as a sustainable model for creating a self-reliant institution, as this palm-based business contributes directly to enhancing the school's income and financial independence. The technology and methods introduced in this program will also be promoted for adoption in other palm-based processing industries to broaden the impact and improve production standards across the sector.

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