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Application of Technology to Increase Palm Sugar Production from Palmyra Sap (Borassus flabellifer L.) in Household Industries in Oirata Village, Southwest Maluku

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Abstract: Southwest Maluku, particularly Kisar Island, has abundant natural resources that can be optimally managed to address food shortages. Meeting food needs through local wisdom is an essential capital that must be strengthened by both the government and the community. One of the island's local potentials is the *koli* tree (*Borassus flabellifer L.*), which grows widely in Oirata Village. Its sap can be processed into *koli* palm sugar, which is highly nutritious and economically valuable. Unlike other sugar sources, the *koli* tree grows naturally without cultivation and can be tapped at any time. However, its production has not yet been properly managed to meet market demand. Through the Community Partnership Program, we introduced appropriate technology in the form of palm sugar cooking equipment to improve both the quality and quantity of *koli* palm sugar. This innovation is expected to expand its market beyond Kisar Island. The program includes community socialization, training on equipment use, production assistance, and product packaging with proper labeling, aiming to empower the people of Oirata Village and enhance their local enterprises.

Keywords: Koli, Palm Sugar, Cooking Equipment, Technology.

Introduction

Kisar Island is one of Indonesia's outermost islands and is part of the administrative area of the South Terselatan Islands District, Southwest Maluku Regency, Maluku Province. The island has a land area of 50.73 km² and consists of six villages: Lekloor, Oirata Timur, Oirata Barat, Abusur, Kotalama, and Wonreli (BPS Maluku, 2023). Commonly known as Yotowawa, Kisar Island is categorized as a very small and outermost island due to its direct border with the waters of Timor-Leste.

Kisar Island is classified as an atoll island with hilly topography and is covered by coral rocks. This topographical condition has led to the island being dominated by *koli* trees, a type of palmyra palm (*Borassus flabellifer L.*), which belongs to the Palmae family. The presence of *koli* trees (Figure 1) is not only a distinctive feature of the island but also provides a significant contribution to the daily lives of the community, both as a source of raw materials and as an important ecological value (Baihaqi et al., 2022).

Figure 1. Koli Tree at Kisar Island

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All parts of the *koli* tree can be utilized by the community, from the trunk and leaves to the male inflorescence (flower cluster). The trunk and leaves are often used as building materials and handicrafts, while certain young parts can be processed as food. Meanwhile, the sap of the inflorescence is used to produce a type of alcoholic beverage known locally as *sopi koli*. In addition, the sap of the *koli* tree serves as the main raw material for making palm sugar. Palm sugar derived from *koli* sap can be used as an alternative to cane sugar, as it contains a higher sugar content of about 27.82% compared to sugarcane or palm sap, which contain only about 12% (Pontoh J, 2007). Besides its high sugar content, *koli* sap also contains 2.28% protein, 3.66% minerals, 1.35% calcium, 1.37% phosphorus, and 0.11% fat (Peraturan Presiden Republik Indonesia, 2025).

However, this great natural potential does not directly correlate with the welfare of the local community. The customary area of Oirata Village, South Terselatan Islands District, Southwest Maluku Regency—which consists of Oirata Timur and Oirata Barat Villages, where the people live in a mixed community—serves as the center of life for the majority of the population, who rely mainly on agriculture and fisheries as their primary livelihoods. The communities in these two villages own extensive *koli* plantations, which are used as raw materials for the traditional production of *koli* palm sugar.

Currently, the processing of *koli* sap is still carried out traditionally using simple tools, such as bamboo stalks for pressing, firewood and cauldrons for cooking, and coconut shell molds for shaping the sugar. During the cooking process, *koli* sap must be continuously stirred manually for around three hours until the sugar thickens (Ratusehaka and Manakane, 2024), making the process highly time-consuming and increasing firewood consumption. Furthermore, the resulting *koli* palm sugar products lack variety, as they are only produced in a single mold shape based on coconut shells (Syahidah et al., 2023).

These issues result in low production levels and relatively high product prices. Therefore, alternative and more modern methods are needed to help the Oirata community produce palm sugar of better quality.

Method

The implementation method was carried out through socialization in the form of counseling, group discussions, and problem-solving using the Focus Group Discussion (FGD) technique. Technical skills in producing *koli* palm sugar were provided by utilizing appropriate technology to ensure ease of application. The appropriate technology applied in the production process of *koli* palm sugar was the Modified Rotating Sand Roaster. Assistance was also provided in the initial production of *koli* palm sugar. The stages of the program implementation that have been carried out include: the survey stage, the socialization stage, the equipment fabrication stage, the equipment trial stage, and the joint production trial stage with the community partners.

Result and Discussion

Survey

The survey activity at the production site of palm sugar in Oirata Village was carried out to observe the actual conditions of the community partners. During the survey, it was found that the raw material, namely the *koli* tree, is abundantly available. However, the production of *koli* palm sugar carried out independently by the community remains very traditional. This results in inefficient production time and suboptimal output. For a single cooking process, it takes about 4–5 hours and produces only 13 pieces of palm sugar from 30 liters of *koli* sap. This limitation occurs because the cooking container can only hold 30 liters of sap. The stirring process is still done manually by hand, making the use of community members' time less efficient for other activities. In addition, the molds used are coconut shells, which do not produce an attractive product shape. Furthermore, no proper packaging process has been applied, as the palm sugar is only wrapped in simple plastic bags.

Figure 2. Survey on the Process of Making Koli Palm Sugar

Socialization (Transformative Learning)

The improvement of community knowledge (transformative learning) was carried out through socialization activities, which included the delivery of materials on the design of equipment for the *koli* palm sugar cooking process, planning of product marketing strategies, and the application of good *Design Thinking* in finding solutions to problems arising during production. The socialization activity took place on August 4, 2025, in Oirata Village, Southwest Maluku Regency. The event was attended by a team consisting of two lecturers and two students, as well as 10 members of the *koli* farmer group from Oirata Village, accompanied by the Head

and Secretary of Oirata Village. The series of socialization activities is shown in Figure 2.

Figure 4. Socialization activity with household industry partner groups

The socialization activity included the presentation of materials (Figure 4) by the two lecturers to the *koli* farmer group from Oirata Village. The event was opened by the Village Head, Charly Y. Wedilen, S.Kep., followed by a brief introduction from the head of the Community Partnership Program (PKM) team, Priska M. Pattiasina, S.Si., M.Sc. The presentation on the application of appropriate technology for the *koli* palm sugar cooking equipment was delivered by Nelson Gaspersz, S.Si., M.Si., a lecturer from the Department of Chemistry, Faculty of Science and Technology, Unpatti. In his presentation, it was explained that one of the main problems faced by the partners is the lengthy cooking process in palm sugar production. This occurs because the cooking process remains conventional, using a cauldron heated with *koli* sap that must be stirred manually throughout. This method is time-inefficient and leads to increased firewood consumption. Production capacity also depends on the availability of raw materials, heating equipment, and firewood, resulting in uncertain and relatively low production output.

In addition, the use of traditional molds made from coconut shells further prolongs the process of removing palm sugar from the molds and produces monotonous shapes. Through the Community Partnership Program (PKM), the team will assist the community by providing appropriate technology in the form of *koli* palm sugar cooking equipment that can be applied in the production process. Several molds made of food-grade silicone were also introduced, which can save time in the molding process because the palm sugar can be easily released once hardened. This palm sugar cooking equipment is expected to help the community partners produce *koli* palm sugar more efficiently, with higher output, greater variety, and improved quality.

The partners were also provided with insights by Priska M. Pattiasina, S.Si., M.Sc. (Lecturer of the Department of Chemistry, Faculty of Science and Technology, Unpatti) regarding packaging design for *koli* palm sugar products. It was conveyed that proper packaging is essential to maintain product quality over a certain period of time. By adding labels to the packaging, the partners' products can become more recognizable and memorable to consumers. Attractive packaging design also increases the product's market value.

This contributes to the growth of *koli* palm sugar production, which can now be packaged with labels and sold at more competitive prices. In addition, in order for the products to reach wider markets, the partners were also informed about the importance of obtaining permits such as PIRT (Household Industry Permit), BPOM (Food and Drug Authority) approval, and Halal certification. With these permits, *koli* palm sugar products can be marketed in various shops and supermarkets.

Training and Trial Production of Koli Palm Sugar with Partners

The *koli* sap harvested by the community was placed into containers filled with kosambi palm fronds. This step was carried out to give the sugar a reddish color and help it solidify. The *koli* sap was then filtered into the sugar cooking device, where it was heated using kosambi firewood for 3–4 hours. The use of *kosambi* wood as fuel was chosen because it generates higher heat intensity compared to kerosene or gas stoves. High heat is essential for the solidification of sugar during the caramelization process.

Due to limited access to kerosene and unstable electricity supply on Kisar Island, particularly in Oirata Village, firewood remains the primary heating medium. The *koli* palm sugar caramel formed was then molded using square and round food-grade silicone molds. After about 10 minutes, the caramel solidified into palm sugar and could be easily removed from the molds.

For powdered *koli* palm sugar, the caramel was spread thinly into flat, square, and round food-grade silicone trays. Once solidified, the sugar was crushed using a container equipped with multiple blades, similar to a chopper, to produce powdered palm sugar.

Both molded and powdered *koli* palm sugar were then packaged. The packaging used was plastic center-seal pouches with label sizes of 15 × 23 cm and 12 × 16 cm. At this packaging stage, the products were sealed with a net weight of 480 grams for molded *koli* palm sugar and 120 grams for powdered *koli* palm sugar.

The overall production flow of *koli* palm sugar is shown in Figure 4.

Figure 4. Production flow of *koli* palm sugar: (a) equipment handover; (b–c) cooking; (d–e) molding; (f) demolding; (g–h) packaging

The training on the production and packaging of *koli* palm sugar was successfully conducted (Figure 8) on September 18, 2025. The partners, a farmer group consisting of 10 members, showed great enthusiasm and active participation throughout the training. Activities included the handover of the *koli* palm sugar cooking equipment to the partners, the use of the cooking equipment, the molding process of solid *koli* palm sugar, the production of powdered *koli* palm sugar, and the packaging process. The packaging stage covered placing the *koli* palm sugar products into plastic packaging, labeling the packages, and using a sealer to ensure airtight conditions, thereby preventing product damage and extending shelf life.

Conclusion

The socialization and training activities succeeded in enhancing the knowledge of the partner group, the farmers from Oirata Village, regarding the application of appropriate technology to make the *koli* palm sugar cooking process more efficient, the use of effective strategies for product marketing to increase sales, as well as problem-solving skills to address challenges that may arise during production. The development of the *koli* palm sugar cooking equipment has enabled partners to produce sugar in larger quantities and in more diverse forms within a single production cycle. Proper packaging using labeled standing pouches has also improved the product's market value and attractiveness. Several recommendations can be suggested, including the establishment of collaborations with the government or other institutions to facilitate the provision of similar equipment, as well as conducting further socialization activities on the processing of other local resources such as corn and peanuts in Oirata Village.

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