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The Application of Solar Dryer Technology in Enhancing Rice Cracker Production in Kromengan Village, Malang

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Abstract

Purpose: To enhance the production and competitiveness of small and medium-sized enterprises (SMEs) specializing in rice cracker production in Kromengan Village, Kromengan District, Malang Regency by implementing solar-powered drying technology.

Method: The community service project was carried out in several phases, beginning with the design and development of the drying equipment. Subsequently, experimentation was conducted with variations in drying rack positions. This was followed by providing training on how to use the equipment. Experimental testing of the equipment was necessary to assess the effectiveness of the drying process using this technology.

Practical Applications: The drying process with this equipment can achieve moisture levels approaching those obtained through direct sun drying. Optimal drying occurred on racks 1 and 2 due to the efficient penetration of sunlight into the drying equipment. Additionally, the use of this equipment helps maintain the cleanliness of rice crackers by preventing dust and other contaminants.

Conclusion: The application of solar-powered drying technology in rice cracker production has the potential to significantly improve the drying process and product quality for SMEs in Kromengan Village. This technology offers a practical solution for enhancing the competitiveness of the rice cracker industry and ensuring product hygiene, ultimately contributing to the economic development of the local community.

Introduction

The diversity of snack foods in Indonesia has seen significant growth, evident in the increasing variety of snack products available in the market. One such snack is "Rengginang," a traditional Indonesian snack made from flattened sticky rice with a diameter ranging from 6 to 7 cm (Perwitasari, 2021; Rizqiati et al., 2022). Rengginang is a popular Indonesian snack known for its unique flavor profile, which is predominantly savory and salty (Alfiyah, 2023). Kromengan Village, located in the Kromengan District of Malang Regency, is known for its household-based food production activities. One of its flagship products is Rengginang, and this production has been ongoing for over two decades. The Rengginang industry in this area is primarily composed of family-based micro, small, and medium-sized enterprises (UMKM).

The Rengginang production process begins with washing glutinous rice, followed by soaking it with various seasonings overnight and subsequent draining. Once the glutinous rice is drained, it is steamed, involving a drying process (Alifatin et al., 2022). Drying is a crucial step in food processing, aimed at reducing moisture content through heating (Firmansyah & Musyahar, 2020; Suryana, 2020). Sun drying is one of the oldest methods for preserving crops and is practiced worldwide (Gorjian et al., 2021; Naing & Soe, 2021). According to the Indonesian National Standard (SNI) 01-4307-1996, the moisture content of Rengginang typically falls between 8% and 12%.

Currently, the drying process employed by UMKM practitioners in Kromengan Village utilizes direct sun drying. This method requires approximately 3 to 4 days for the drying process. Unfavorable weather conditions can lead to slower drying and the potential development of mold on the Rengginang. The conventional drying method used by the partners can be observed in Figure 1.

Figure 1. Conventional Rengginang Drying Process

Based on these considerations, it becomes essential to implement innovative solar-based drying technology to enhance productivity and maintain the hygiene of Rengginang products. Additionally, other supporting activities for productivity enhancement and competitiveness include providing guidance for SPP-IRT certification and Halal certification.

Method

This community service project was conducted in Kromengan Village, Kromengan District, Malang Regency. The collaborating partners in this endeavor are the Rengginang producers who have been in operation for approximately 20 years. Addressing the partner's issues in management and production processes, various support activities were carried out. In the field of management, the assistance primarily revolved around licensing-related matters. Simultaneously, in the production process domain, the focus was on improving the drying process to accelerate production when compared to the pre-implementation of solar drying technology.

Materials used for this community service project were categorized based on the

specific problem areas. For the management aspect, the materials included support materials and documents related to the partnership. On the other hand, materials used for the construction of the drying equipment included polycarbonate, stainless steel, galvalume plates, wheels, iron plates, and cashew. These materials were assembled according to the previously designed concept. The design concept of the applied drying equipment can be seen in Figure 2.

Figure 2. Solar-Powered Drying Equipment Design Concept

The implementation procedure for Community Service consists of two main areas (Management Field and Production Process Field). Activities conducted in Management field consist of three primary activities (1) Socialization and Assistance for Food Production - Household Industry Certification: This involves the introduction and guidance for obtaining certifications related to food production within the household industry; (2) Socialization and Assistance for Halal and Hygiene Certification: Activities focused on educating and assisting in obtaining Halal and hygiene certifications for the products; (3) Socialization and Assistance for Labeling and Packaging: The final set of activities revolves around educating and aiding in the appropriate labeling and packaging of the products.

Activities conducted in Production Process Field consist of some activities (1) Equipment Fabrication: The creation of the drying equipment is based on a predefined design concept. After site measurements, the equipment is constructed using a robust iron frame to withstand weather conditions. The primary frame is a rectangular structure measuring 2 m x 1.5 m x 1.75 m, divided into four sections for trays. The top section resembles a triangular roof, designed to maximize exposure to sunlight within the drying equipment; (2) After the main frame is completed, the next step involves painting it to minimize corrosion due to weather exposure, as the drying equipment will be placed outdoors; (3) Tray Manufacturing: Given that the drying equipment comprises stacking trays, the distance between them is predetermined to optimize heat exchange. Ventilation openings are installed at the top between the racks and the roof to facilitate air circulation. Handles are added to both sides of the trays for easy loading and unloading; (4) Polycarbonate Installation: Polycarbonate sheets are installed as a covering for the drying equipment. The polycarbonate is expected to optimize the drying process and protect the Rengginang from dust and other contaminants during the drying process; (5) Wheel Installation: Wheels are added to the bottom of the equipment for easy repositioning to track the sun. Supports are also affixed to the rigid parts of the equipment to extend the wheel's lifespan; (6) Door Placement: Doors are installed on both sides of the equipment to allow access to the trays for loading and unloading; (7) Equipment Testing: After the completion of the drying equipment, a testing process is conducted to evaluate its effectiveness. Testing involves comparing conventional drying methods with the new equipment, with observations made every two days to assess the condition of the Rengginang; (8) Equipment Usage Training: Following successful testing, training sessions are conducted

to educate users on the proper utilization of the equipment.

Result

The Community Service activities were held in Kromengan Village, Kromengan District, Malang Regency, and were conducted in collaboration with the Malang Regency Health Office and the UMM Halal Center. These activities also involved the participation of students as part of the implementation of the Community Service Learning (MBKM) program outside the campus.

1. Socialization and Assistance for SPP-IRT (Household Industry) Certification:

   This activity took place at the Kromengan Village Office and was attended by local household industry entrepreneurs in Kromengan Village. The event was initiated by the Village Head of Kromengan and continued with the core activity, which was the socialization and assistance for the certification of Household Industry Production (SPP-IRT). This activity was carried out in collaboration with the Malang Regency Health Office, which provided detailed information regarding the importance and procedures for obtaining SPP-IRT certification. During this session, various essential requirements that needed to be prepared by the entrepreneurs for registering and processing the SPP-IRT certification were conveyed. Among the prerequisites discussed, one crucial element was the possession of a Business Identification Number (NIB) by the entrepreneurs. The implementation of this activity is illustrated in Figures 3 and 4.

Figure 3. Presentation of SPP-IRT Material

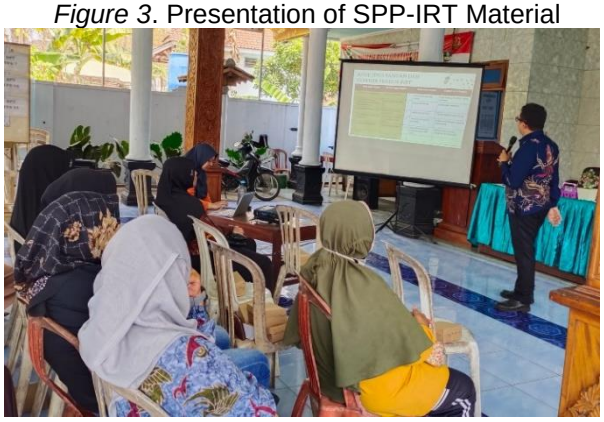


Figure 4. Speaker during the SPP-IRT Socialization Activity

2. Halal and Hygiene Certification Socialization and Assistance:

   This activity was conducted at the partner's home and was attended by entrepreneurs from the Rengginang and kerupuk (crackers) groups. The event was held in collaboration with the UMM Halal Center. During this session, information was

provided regarding the importance of halal and hygiene certification in food production. The implementation of this activity is depicted in Figures 5 and 6.

Figure 5. Involvement of Students in the Activity

Figure 6. Implementation of Halal Certification Socialization and Assistance

3. Labelling and Packaging Socialization and Assistance

This activity is essential for partners to enhance the competitiveness of their products. It was conducted at the partner's residence and was specifically tailored to the Rengginang group. The objective was to improve the quality and presentation of their products, thereby increasing their competitiveness in the market. The execution of this activity is illustrated in Figures 7 and 8.

Figure 7. Labelling and Packaging Socialization

Figure 8. Packaging Practice

4. Design and Implementation of Innovative Solar-Powered Drying Technology

   The drying process used by our partners so far has relied on conventional sun drying, as depicted in Figure 9.

Figure 9. Drying Process with Direct Sunlight Exposure

The drying process with this system requires a time span of 4 days. On the first day, it is essential to flip the Rengginang to ensure maximum drying. The technology introduced to our partners utilizes a simple yet efficient stacking rack system that is enclosed to optimize the drying process, protect against various weather conditions, and maintain hygiene. This equipment minimizes the entry of dust or other contaminants into the drying area, as demonstrated in Figures 10 and 11.

Figure 10. Drying Equipment Frame

Figure 11. Solar-Powered Drying Equipment

The formed Rengginang is arranged in trays to be placed in the drying equipment. The equipment has a capacity of 24 kg, as illustrated in Figures 12 and 13.

Figure 12. Arrangement of Rengginang on the Tray

Figure 13. Arrangement of Trays on the Drying Equipment

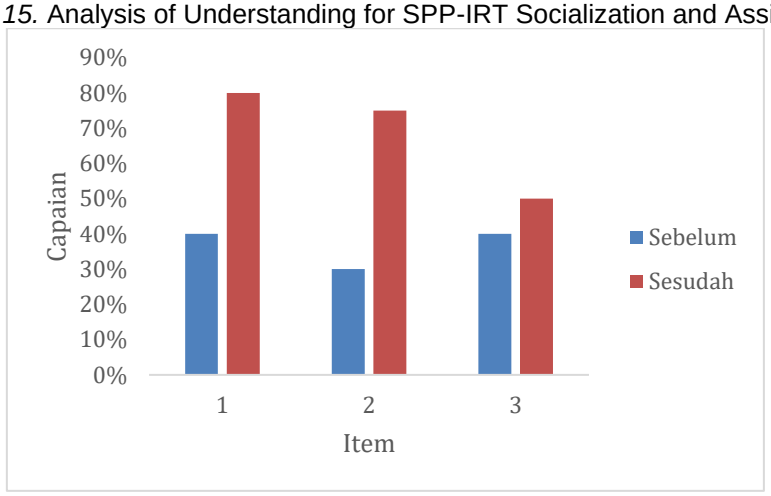
The design and development of the drying equipment prototype were carried out gradually, involving students in the implementation process. The drying equipment, which consists of 4 racks, features doors on two different sides to facilitate the removal and placement of trays during both the drying and post-drying processes. This design can be observed in Figure 14.

Figure 14. Handover of the Drying Equipment to the Partners

Discussion

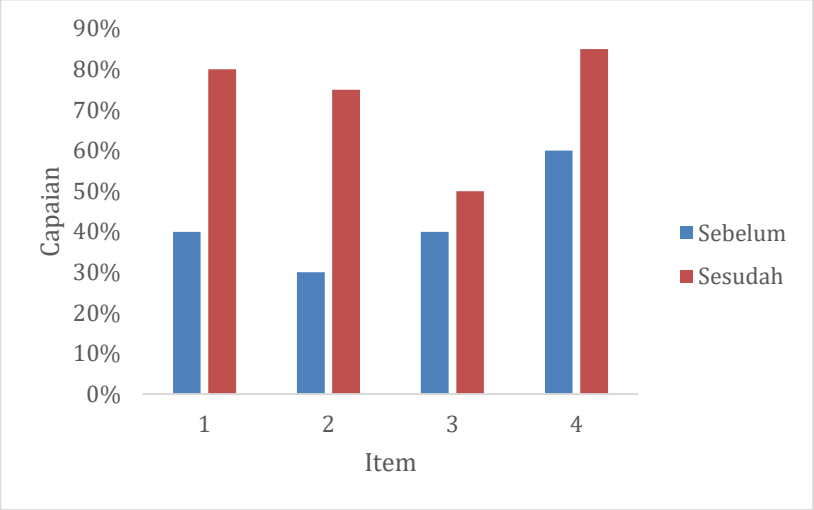
Based on the results of the socialization and assistance provided for the three activities, namely SPP-IRT Socialization, Halal & Hygiene Certification, and Labelling & Packaging, the analysis of the level of understanding of the SPP-IRT socialization and assistance among participants can be observed, as depicted in Figure 15.

Figure 15. Analysis of Understanding for SPP-IRT Socialization and Assistance



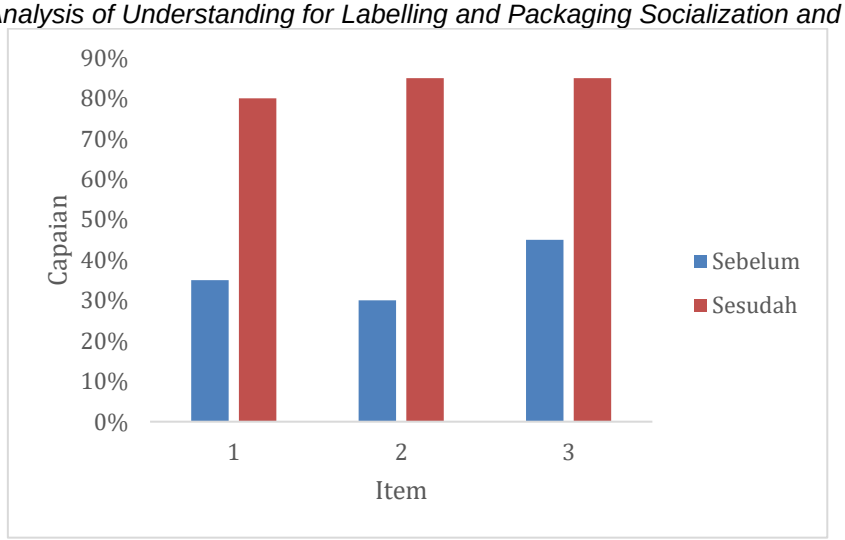
Based on Figure 15, the data shows a noticeable increase in participants' knowledge and understanding following the socialization and assistance activities. This improvement can be attributed to the fact that, before receiving the socialization, participants had limited knowledge or might have been entirely unfamiliar with the topic, perhaps hearing about it for the first time. The significant increase in the percentage of understanding achievement for each item provided is also influenced by behavioural learning factors. The combination of learning methods during the socialization and assistance activities served as the foundation for changing the participants' knowledge, as described by (Rosida et al., 2023; Wijayanto et al., 2021). The analysis of understanding for the Halal and Hygiene Certification socialization and assistance among participants can be observed in Figure 16.

Figure 16. Analysis of Understanding for Halal & Hygiene Certification Socialization and Assistance



In Figure 16, the evaluation items include the Meaning of Halal and Hygiene, Understanding of the Provided Material, Elements of Halal, and Halal Certification Requirements. It is evident that there has been a significant increase in understanding based on these four items. The enthusiasm of the eight participants during the socialization played a crucial role in this improvement. Additionally, the combination of teaching methods, including lectures, presentations, and practical exercises during the activity, contributed to the changes in understanding. This is in line with the findings of (Hidayat et al., 2019), who stated that the combination of teaching methods during outreach activities significantly influences participants' understanding, such as lectures, practical exercises, field trips, presentations, and teaching materials or media. As for the analysis of understanding for the Labelling and Packaging socialization and assistance among participants, it can be observed in Figure 17.

Figure 17. Analysis of Understanding for Labelling and Packaging Socialization and Assistance



In Figure 17, it is evident that the partners' knowledge has significantly improved following the socialization and assistance regarding the importance of labelling and packaging. Labels are crucial because they are used in the process of obtaining SPP-IRT for the partners. Several interrelated aspects between the need for SPP-IRT and Halal certification contribute to the participants' enthusiasm.

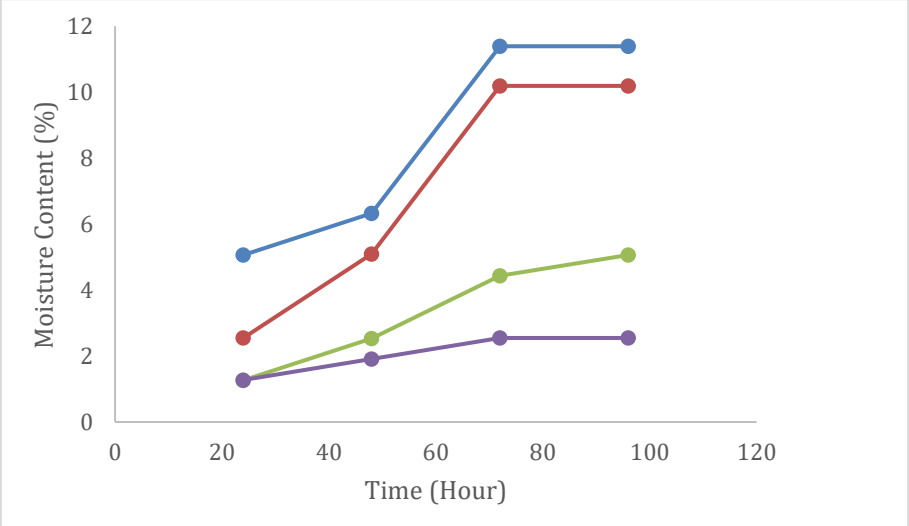
The drying equipment underwent testing to determine its functionality and suitability for use. Several observation notes were taken to collect sufficient data. Based on the observation data, the results can be seen in Table 1 below.

Table 1. Data on Moisture Content Reduction During the Drying Process

Time (Hour)	Mass (Grams)				Moisture Content			
	Shelf 1	Shelf 2	Shelf 3	Shelf 4	Shelf 1	Shelf 2	Shelf 3	Shelf 4
0	15,8	15,7	15,8	15,7				
24	15	15,3	15,6	15,5	5,06329	2,5478	1,2658	1,2739
48	14,8	14,9	15,4	15,4	6,32911	5,0954	2,5316	1,9108
72	14	14,1	15,1	15,3	11,3924	10,1911	4,4304	2,5478
96	14	14,1	15	15,3	11,3924	10,1911	5,0633	2,5478

Based on Table 1, a relationship between time (hours) and moisture content (%) can be established, as shown in Figure 18.

Figure 18. Relationship between Moisture Content (%) and Drying Time (hours)



In Figure 18, it can be observed that as drying time increases, the amount of moisture evaporated during the drying process also increases. The shelf placement significantly affects the drying process, as seen in the rapid drying of Shelf 1 and Shelf 2 due to maximum sun exposure, while Shelf 3 and Shelf 4 are still in the ongoing drying process. Figure 18 also reveals that the drying process is influenced by various factors, as mentioned by (Hardianti et al., 2017). During the drying process, food materials undergo significant changes in physical, chemical, and nutritional characteristics. These materials undergo modifications due to mass and heat transfer processes (Laksono et al., 2017). Drying materials are modeled as stochastic diffusion processes that transport water molecules from areas of high concentration to low concentration. Water molecules evaporate from the material's surface. The model predicts the expected humidity ratio as a function of accumulated exponential evaporation (Dima, 2019). The drying process itself is simple yet highly complex due to the interplay of temperature changes, especially under real-world conditions (Gupta et al., 2017; Singh et al., 2018; Soebiantoro et al., 2018).

Conclusion

Behavioral changes in society can occur through various interventions, including delivering lectures, presentations, or practical demonstrations to the community. The adoption of technology can also have a significant influence on changing community behavior, especially in the process of increasing productivity and competitiveness. Developing technology that addresses the specific challenges faced by partners is essential in the application of appropriate technology. The results of this community service activity can also be applied to similar food products such as various types of crackers and chips.

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