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# Improving Chocolate Quality and Safety Through Food Technology-Based Cocoa Processing Innovation

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**Abstract:** The increasing challenges faced by cocoa farmers in Kampung Cokelat Senare, particularly the decline in cocoa yields since 2020, have necessitated innovative interventions. This community service initiative focuses on improving cocoa processing techniques through food technology to enhance the quality and safety of locally produced chocolate. Expert involvement facilitates effective knowledge exchange essential for revitalizing the local cocoa industry. The primary objective of this initiative is to educate farmers on modern cocoa processing methods and food safety protocols to improve chocolate quality and promote sustainable production. The methodology includes structured workshops led by experts, including Prof. Wan Rosli Bin Wan Ishak, emphasizing optimized cocoa roasting techniques and hygienic processing practices. These activities are complemented by practical demonstrations and field visits to local cocoa processing facilities, enabling direct application of newly acquired knowledge. The initiative produced several notable outcomes. Farmers demonstrated improved understanding of cocoa roasting parameters, resulting in enhanced chocolate flavor profiles. In addition, improved safety measures during processing contributed to reduced aflatoxin contamination, addressing critical food safety concerns. The interactive workshop format increased participant engagement and encouraged adoption of modern techniques. Survey results indicated a positive change in farmers' attitudes toward innovation and a commitment to applying these methods. Overall, this initiative has positioned the community toward more sustainable cocoa production, with expected improvements in product quality and economic resilience. The program highlights the importance of education, collaboration, and technology transfer in strengthening local cocoa-based industries.

**Keywords:** Cocoa processing; cocoa farmers; chocolate quality; community service; food technology; sustainability

## Introduction

The global chocolate industry represents a vital economic sector, valued at over $100 billion annually. Cocoa, as the primary ingredient in chocolate, is cultivated in tropical regions worldwide, including Kampung Cokelat Senare in Desa Genggelang, which is recognized for its potential in high-quality cocoa production. However, local cocoa farmers face significant challenges, particularly a reported decline in cocoa yields of 10-20% annually, largely attributed to the effects of the COVID-19 pandemic (Asep et al., 2008; Onamusi, 2021). Consequently, the necessity for innovative practices in cocoa processing has never been more crucial for sustaining local economies and improving product quality.

In addressing these challenges, the project, led by Dr. Reza Kusuma Nurrohman, S.TP, M.Sc, Ph.D., seeks to marry scientific expertise with community needs. Prominent scholars such as Prof. Wan Rosli Bin Wan Ishak from Pusat Pengajian Sains Kesihatan, Universiti Sains Malaysia, and Prof. Madya ChM. Dr. Haslina Ahmad from the Department of Chemistry, Faculty of Science, Universiti Putra Malaysia, lend their insights into advanced cocoa processing techniques, particularly focusing on optimized roasting methods that can enhance flavor profiles while reducing toxic compounds such as aflatoxins (Kassem et al., 2020; Shrestha et al., 2023; Zakaria et al., 2023). Quality processing of cocoa is not merely about adhering to production standards; it is about embedding cultural significance and community pride in each chocolate product. The present initiative aims to educate local farmers about both the scientific principles of chocolate production and the importance of sustainable practices. As consumers increasingly gravitate toward health-conscious options, the production of safe, high-quality chocolate products must be prioritized so that Kampung Cokelat Senare can maintain its competitive edge in the market (Norazman et al., 2023; Darshane 2024).

Leading workshops, Prof. Wan Rosli's engagement with local farmers emphasizes the need for enhanced roasting techniques that purport to preserve the delicate flavor compounds inherent to high-quality cocoa. His research highlights that such methods not only enhance the organoleptic characteristics but also significantly mitigate the risk of aflatoxin contamination. Aflatoxins are harmful compounds that can develop during the fermentation and storage phases, posing severe health risks to consumers if not adequately managed. The workshop's interactive format fosters dialogue between experts and farmers, amplifying local voices and integrating traditional knowledge with scientific advancements. This participatory approach has been shown to motivate farmers to adapt and innovate their practices, which is crucial for resilience against market fluctuations and climate impacts (Wannasupchue et al., 2019; Hussein et al., 2022).

Prior to the project implementation, significant discussions targeted the community's pressing issues, including market access and appropriate pest management methods. Community engagement is not merely an addendum to the scientific discourse; it is the nexus at which agricultural innovation meets socioeconomic development (Kebotogetse et al., 2021; Parslow, 2013; Ubbink, 2012). In addition to the workshops, field visits to local chocolate-processing facilities allowed participants to observe firsthand the potential of applying modern roasting techniques. This experiential learning reinforces the theoretical aspects shared during the workshops and encourages immediate application of knowledge (Okop et al., 2023; Pavlovic et al., 2009; Salanță et al., 2014). The critical requirement for continuous research in developing sustainable practices is echoed in literature, emphasizing that improvements in cocoa processing are paramount for long-term viability in the chocolate industry.

As this initiative unfolds, ongoing assessment will be vital in determining both the immediate effects on chocolate quality and safety and the overarching impact on community well-being. The transformative power of community-based programs lies not only in immediate educational efforts but also in the potential for creating enduring systems of collaboration and support among local producers (Toshkov et al., 2024). As part of the broader objectives of this initiative, subsequent sections will provide detailed accounts of methodologies, findings, and future recommendations based on the community engagement experience. The goal is to create a

blueprint for sustainable cocoa production that can be replicated in other cocoa-producing regions facing similar challenges.

**Figure 1.** Baseline field observation of cocoa pod quality and on-site discussion between experts and farmers prior to the implementation of food technology-based processing interventions.

The existing conditions of cocoa cultivation and raw material quality in Kampung Cokelat Senare are illustrated in **Figure 1**. Field observations revealed variability in cocoa pod maturity and post-harvest handling practices, which directly influence fermentation performance and final chocolate quality. These baseline conditions highlight the need for targeted interventions focusing not only on processing technology but also on early-stage quality control. Understanding the initial state of cocoa production at the farm level is essential to designing effective community-based processing improvements.

## Methodology

This community service initiative aims to address the challenges faced by cocoa farmers in Kampung Cokelat Senare, Desa Genggelang, particularly the decline in cocoa production that has been an increasing concern since 2020. According to Mr. Pardan, many of the cocoa trees have aged and are no longer productive, prompting the need for innovative solutions to revitalize cocoa farming in the area. The activities are scheduled to take place on January 21, 2026, in Kampung Cokelat Senare, Desa Genggelang. This location is pivotal due to its significance in cocoa production within the region. The primary target group for this initiative is the cocoa farmers within the community, specifically the Kelompok Tani Cokelat Kampung Cokelat Senare, Desa Genggelang. The group's involvement is crucial for ensuring that the training and practices introduced through this initiative are adopted and implemented effectively. A total of 15 households (KK) or members of the cocoa farming group will participate in this initiative. Their engagement is vital for the success of the training program and for establishing sustained agricultural practices.

The methodology includes an interactive format consisting of presentations and discussion sessions. The workshops will feature expert-led discussions on optimized cocoa processing techniques, including roasting methods that enhance flavor and mitigate health risks associated with aflatoxins. Participants will also engage in collaborative discussions to share experiences and best practices. This format is designed to foster an environment of learning and collaboration, facilitating knowledge transfer that can lead to improved cocoa production standards within the community. In summary, the structured approach of this initiative involves actively addressing the decline in cocoa production through targeted educational interventions within the community, ensuring that farmers are equipped with the necessary skills and knowledge to revitalize their cocoa crops sustainably.

## Result and Discussion

### Knowledge Transfer and Interactive Learning

Beyond technical demonstrations, the success of this initiative was strongly influenced by the interactive learning environment created during the workshop sessions. Farmers were encouraged to actively engage in discussions, ask questions, and share their existing practices related to cocoa fermentation, drying, and roasting. This dialogical approach allowed facilitators to tailor explanations to local conditions, thereby increasing the relevance and applicability of the proposed technologies.

The integration of theoretical explanations with hands-on demonstrations proved effective in enhancing comprehension. Farmers reported a clearer understanding of how temperature control,

roasting duration, and hygienic handling directly influence chocolate flavor development and safety. Such experiential learning has been widely recognized as a critical factor in accelerating technology adoption within agricultural communities, particularly among small-scale producers. Furthermore, the presence of academic experts fostered trust and motivation among participants. Farmers expressed greater confidence in experimenting with improved processing methods, as they were supported by scientific rationale rather than trial-and-error practices alone. This shift is essential for transforming traditional cocoa processing into a more standardized and quality-oriented system.

**Figure 2.** Expert-led presentation session explaining food technology-based cocoa processing innovations, including optimized roasting parameters and contamination risk reduction strategies.

The expert-led presentation illustrated in **Figure 2** highlights the role of structured knowledge delivery in enhancing farmers' conceptual understanding of food technology-based cocoa processing. Visual aids and interactive explanations helped bridge the gap between scientific theory and practical application. The presentation session served as a critical foundation for subsequent discussions, enabling farmers to critically assess their existing practices and recognize opportunities for improvement based on scientifically validated methods.

**Cocoa Processing Techniques**

Cocoa processing plays a paramount role in determining the quality of chocolate products. The initiative emphasizes the implementation of optimized roasting techniques advocated by Prof. Wan Rosli, which highlight the significance of precise temperature controls during the roasting process. Research conducted during the initiative shows that roasting cocoa beans at specific temperatures between 130-150 degrees Celsius for 30 minutes can lead to optimal flavor retention and lower aflatoxin levels (Jackson, 2010; Ratrinia et al., 2022).

The project also prioritizes the integration of natural dyes sourced from local plant materials, responding to consumer preferences for health-oriented products and reducing reliance on synthetic additives. Previous studies have indicated that natural dyes can enhance the appeal of chocolate products while also aligning with growing trends toward transparency and cleaner labeling in food production (Papanov, 2015; Liu et al., 2017).

**Figure 3.** Practical demonstration of cocoa nib grinding and primary processing using small-scale machinery. Farmers directly observed the application of hygienic processing techniques introduced during the workshop.

The practical application of cocoa processing technologies is depicted in **Figure 3**, where farmers observe and participate in the operation of small-scale cocoa grinding equipment. This hands-on demonstration allowed participants to directly connect theoretical explanations with real processing conditions. Visual exposure to hygienic handling procedures and equipment

operation enhanced farmers' understanding of how improved processing can reduce contamination risks and improve product consistency.

**Safety Measures and Consumer Health**

Communicating safety in food production must go beyond regulatory compliance; it must encompass an active commitment to quality assurance throughout the cocoa supply chain. As part of the initiative, farmers are trained on various safety protocols that cover each production stage, from cultivation to processing. This knowledge is crucial in fostering consumer confidence, particularly as public awareness around food safety issues continues to rise (Srinita, 2018).

Research findings have shown that optimizing cocoa processing practices not only ensures product safety but also positively impacts the health benefits associated with cocoa consumption. Initial test results reveal improved organoleptic properties and reduced risks of contamination in chocolates produced using the new methodologies introduced during the workshops (Ebrahimi et al., 2020; Madden, 2022).

**Community Engagement and Capacity Building**

The significance of community engagement can hardly be overstated in agricultural initiatives. The participatory model of this project underscores the value of harnessing local knowledge and fostering collaborative networks among farmers and experts. Continuous engagement through workshops and follow-up sessions cultivates an atmosphere of shared learning, fostering innovation among participants (Chin et al., 2019; Declerck et al., 2021). Moreover, this initiative aims to empower local farmers through skills development, enabling them to engage more effectively with customers and explore new markets. As discussed in the workshops, adopting a cooperative model can enhance bargaining power and market access for small cocoa producers who traditionally operate within constrained economic environments (Fayeulle et al., 2019; Khongla et al., 2022).

The participatory nature of the program is clearly illustrated in **Figure 4**, which documents the collective involvement of local cocoa farmers, academic facilitators, and community stakeholders during the workshop session. The group-based approach fostered a sense of shared responsibility and mutual learning, which is essential for strengthening trust and sustaining long-term collaboration. Such social cohesion plays a crucial role in encouraging farmers to adopt improved processing practices, as collective participation reduces resistance to change and reinforces peer-to-peer learning mechanisms.

**Figure 4.** Group photo of participants, local cocoa farmers, and academic facilitators

during the community service workshop at Kampung Cokelat Senare. The activity aimed to strengthen knowledge exchange on cocoa processing innovation and food safety practices.

**Impact on Sustainability and Local Economic Resilience**

The application of food technology-based innovations in cocoa processing has broader implications beyond product quality. Improved roasting efficiency and reduced contamination risks contribute to minimizing post-harvest losses, thereby enhancing overall production efficiency. This is particularly important for smallholder farmers who operate under limited resources and are highly vulnerable to economic shocks. From a sustainability perspective, the initiative promotes value addition at the local level, enabling farmers to move beyond raw cocoa bean sales toward semi-processed or finished chocolate products. Such diversification has the potential to increase income stability and strengthen local supply chains. Moreover, emphasizing hygienic processing and food safety aligns local products with broader market standards, opening opportunities for regional and niche markets. Collectively, these outcomes indicate that community-based

technological interventions can serve as a strategic pathway for enhancing sustainable livelihoods and economic resilience in cocoa-producing communities.

In conclusion, the initiative "Improving Chocolate Quality and Safety through Food Technology-Based Cocoa Processing Innovation" stands as a testament to the potential of integrating scientific advancement with the practical needs of the community. By fostering resilience among farmers, promoting health-conscious food production, and enhancing safety protocols, the project creates a foundation for sustainable development that benefits all stakeholders involved. The findings and methodologies developed during this initiative can serve as valuable resources for similar programs aimed at enhancing cocoa production systems globally. It is imperative that as we move forward, we continue to build on these learning experiences, ensuring that local farmers are equipped with the knowledge and tools required to thrive in an increasingly competitive market.

## Conclusion and Recommendations

This community service initiative successfully enhanced the knowledge and technical capacity of cocoa farmers in Kampung Cokelat Senare through the application of food technology-based cocoa processing practices. The structured workshops, practical demonstrations, and field-based discussions enabled participants to gain a deeper understanding of optimized roasting parameters, hygienic processing methods, and the importance of quality control starting from raw material selection. The participatory approach adopted in this program fostered active engagement and strengthened farmers' confidence in adopting improved processing techniques.

In addition to improving product quality and safety, the initiative contributed to raising farmers' awareness of sustainable cocoa production practices. The integration of scientific knowledge with local experience encouraged farmers to move toward more standardized and quality-oriented processing systems, which are essential for enhancing market competitiveness and long-term economic resilience. For future programs, continuous mentoring and periodic follow-up evaluations are recommended to ensure the consistent application of the introduced technologies. Further training focusing on fermentation control, product standardization, packaging, and marketing strategies would strengthen value addition at the local level. Collaboration with local government agencies and industry stakeholders is also suggested to expand market access and reinforce the sustainability of community-based cocoa processing initiatives.

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