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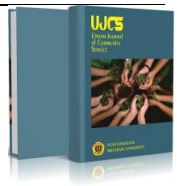

Community Empowerment Through the Diversification of Rosella Products into Fermented Kombucha

Ni Made Ayu Suardani Singapurwa[1]*, Aida Firdaus Muhammad Nurul Azmi[2], A A Made Semariyani[1], Luh Suriati[1], I Wayan Sudiarta[1], Ni Luh Putu Putri Setianingsih[1], Anak Agung Sagung Manik Chindrawati[1], Ni Made Defy Janurianti[1]

[1] Food Technologi and Agricultural Products, Faculty of Agriculture Science and Technology, Warmadewa University, Denpasar, Indonesia.
[2] Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.

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Corresponding Author:
Ni Made Ayu Suardani Singapurwa
a.suardani@gmail.com

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Abstract: This community service program aimed to enhance the added value of roselle (Hibiscus sabdariffa L.) through the development of kombucha as a functional beverage while empowering the GAPOKWATAN Lumbung Rasa women farmers' group in Pitra Village, Bali. Prior to the intervention, roselle utilization was limited to dried tea production with low economic value, constrained by limited knowledge, technology, and market access. The program introduced appropriate postharvest technologies, including training in Good Manufacturing Practices (GMP) and Sanitation Standard Operating Procedures (SSOP), fermentation using Symbiotic Culture of Bacteria and Yeast (SCOBY), and product packaging and labeling. Members were also supported with fermentation and packaging equipment to standardize production. Pre- and post-program assessments revealed substantial improvements: hygienic processing increased from 30% to 80%, fermentation skills from 20% to 75%, packaging quality from 25% to 70%, technology adoption from 15% to 85%, and product diversification from 10% to 65%. Beyond technical capacity, the program fostered social empowerment, as women transitioned from supplementary laborers to key innovators and decision-makers in production and marketing. Economically, the group achieved routine production of 10–15 liters of kombucha per week, with an average selling price of IDR 20,000–25,000 per 250 ml bottle, resulting in a 40–50% increase in income compared to previous activities. Environmentally, the process is considered sustainable, as it relies on locally available raw materials without generating hazardous waste. Overall, this initiative demonstrates that roselle kombucha innovation can strengthen community empowerment, gender inclusivity, and local economic sustainability while contributing to functional food development.

Keywords: Diversification, Fermentation, Kombucha, Roselle.

Introduction

The Farmers Group Association (GAPOKTAN) is an organization formed with the aim of increasing economic scale, business efficiency, strengthening farmer institutions, and facilitating various activities related to agriculture. GAPOKTAN also functions as a forum for processing and marketing agricultural products, as well as providing access to supporting services such as the use of agricultural machinery, commodity processing technology, and the development of partnership networks. Through its role, GAPOKTAN is expected to increase the productivity, income, and quality of life of its members. One of the group's active in GAPOKTAN is GAPOKWATAN Lumbung Rasa, located in Pitra Village, Penebel District, Tabanan Regency, Bali. This group is led by Ns. Ni Kade Ayu Dharma Putri, S.Kep, with a membership of 23 Women Farmers Groups (KWT) affiliated with Pondok Indi. The group's main commodity is rosella, along with other local potentials such as passion fruit, taro, and other food crops. Cultivation innovations have also been

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implemented, such as planting rosella using an intercropping system with Brazilian spinach.

Roselle (*Hibiscus sabdariffa* L.) is a horticultural plant with high economic and health value. In addition to food products, roselle has also been used in various applications, including cosmetics and pharmaceuticals (Hapsari et al., 2021). Roselle plants are a popular source of vegetable protein, fat, and minerals (Salami & Afolayan, 2021). The most widely used parts of the roselle plant are the petals, seeds, leaves, and stems, as they contain many nutrients that are beneficial to health. The high utility value of roselle is associated with its potent natural phytochemical compounds, which are found throughout the plant, especially in the roselle flower petals (Sari et al., 2023). It is rich in vitamin C, vitamin A, vitamin B, fiber, calcium, phosphorus, magnesium, and iron (Muliana et al., 2024). The petals are rich in bioactive compounds, including anthocyanins, flavonoids, polyphenols, and vitamin C, which act as natural antioxidants (Karmana, 2023). Roselle flower petals contain high levels of anthocyanins, particularly delphinidin 3-O-sambubioside and cyanidin 3-O-sambubioside (J. Li et al., 2022). These compounds are beneficial in reducing the risk of degenerative diseases, boosting the immune system, and providing a refreshing effect (Maslahah et al., 2024). In addition to being brewed as an herbal drink, rosella has excellent potential to be developed into a variety of innovative value-added processed products.

The use of rosella has been limited so far, and the group wants to increase knowledge and income by developing competitive products, especially by taking advantage of market opportunities from domestic and foreign tourists visiting the Jatiluwih tourist destination. One innovation that can be created from rosella is kombucha. Kombucha is a drink made from fermenting tea or herbal ingredients using Symbiotic Culture of Bacteria and Yeast (SCOBY) (Sutthiphatkul et al., 2023; Zailani & Adnan, 2022). During the fermentation process, microorganisms in SCOBY convert sugar compounds into organic acids, vitamins, amino acids, and other bioactive compounds (Khamidah et al., 2020; Yustin et al., 2025). This process not only creates a unique taste with a combination of sour, sweet, and slightly carbonated qualities but also provides health benefits, such as improving digestive health, aiding detoxification, and potentially supporting the immune system. The combination of hibiscus and kombucha produces a functional beverage with high nutritional value, an appealing taste, and broad market potential (S. Li et al., 2024). Hibiscus kombucha has demonstrated significant antibacterial activity, particularly against Escherichia, with the most effective inhibition observed after 15 days of fermentation (Chofidah et al., 2019; Cholidah et al., 2020). This drink is rich in antioxidants, which, although slightly reduced during fermentation, remain effective. It also significantly reduces cholesterol levels, with a 56% reduction observed in one study (Suhartatik et al., 2009). In animal studies, roselle kombucha has been shown to maintain standard blood profiles, indicating potential benefits for human blood health (Hidayanti et al., 2014). Through various studies, it has been proven that roselle flowers can lower blood pressure, creatinine, uric acid, and have anti-diabetic and anti-cancer properties (Harmili et al., 2021; Malacrida et al., 2022; Wang et al., 2022).

The partner group faces a number of obstacles, including limitations in packaging rosella processed products that can last a long time at an affordable price, as well as obstacles in broader marketing strategies. In addition, sustainability issues, particularly in terms of production waste management, are challenges that need to be addressed. Nevertheless, GAPOKWATAN Lumbung Rasa processed products are becoming known for their taste and attractive packaging, and have even made their way into renowned restaurants such as The Lava, as well as being frequently showcased at various exhibitions. This achievement shows that there's huge potential that can be developed further with the support of technology, innovation, and ongoing assistance. So, efforts to develop and empower GAPOKWATAN Lumbung Rasa are important, not only to improve the quality and quantity of rosella-based products, but also to strengthen institutional capacity, expand marketing networks, and create a sustainable and environmentally friendly model for managing farming businesses.

Method

The activity was carried out using a direct trial method with a partner, GAPOKWATAN Lumbung Rasa, located in Pitra Village, Penebel District, Tabanan Regency, Bali, with a total of 20 members. The implementation began with an introduction to Appropriate Technology in Roselle post-harvest processing, specifically fermentation into kombucha. The implementation stages included: (1) providing knowledge about sanitation and hygiene based on Good Manufacturing Practices (GMP) and Sanitation Standard Operating Procedures (SSOP); (2) training in kombucha production, from raw material preparation and fermentation using Symbiotic Culture of Bacteria and Yeast (SCOBY) to storage techniques; (3) training on packaging, labeling, and product storage to meet food safety standards; (4) training on marketing and entrepreneurship to expand the product's reach to the local tourism and culinary markets; and (5) providing equipment for fermentation, bottling, and packaging to support the sustainability of the production process.

Data collection methods included observation, questionnaires, and interviews with partners to assess improvements in skills, product quality, and production quantity. Data analysis was conducted descriptively by comparing conditions before and after the program, both subjectively and objectively, to assess the program's effectiveness in increasing production capacity and ensuring business sustainability.

Result and Discussion

The introduction of appropriate technology in the handling and processing of roselle post-harvest, combined with kombucha, helps solve partner problems. This group received knowledge and skills on Good Manufacturing Practices (GMP) and Sanitation Standard Operating Procedures (SSOP). They were also provided with the necessary equipment for fermentation, packaging, and labeling, enabling them to standardize their production systems. The aspects of packaging and labeling supported by modern equipment contribute to increasing the added value of the product. Good packaging not only serves as protection against contamination but also functions as a medium of information for consumers regarding nutritional content, health benefits, and product identity (Bou-Mitri et al., 2021; Schifferstein et al., 2021). Thus, the provision of supporting equipment has an impact not only on technical efficiency but also contributes significantly to the competitiveness of Roselle kombucha products in both local and regional markets (Yan et al., 2022). The application of post-harvest technology improves the quality and economic value of roselle products (Haryanto et al., 2023).

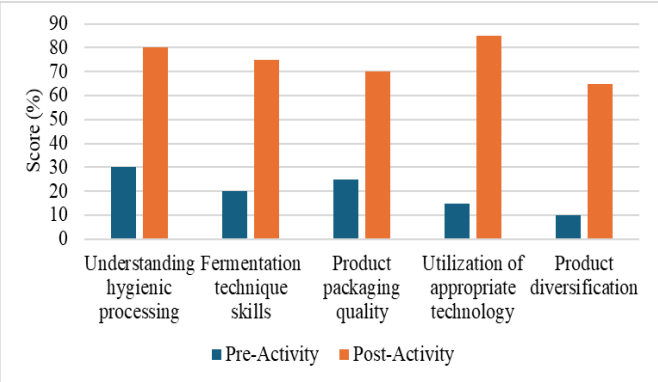

Figure 1. The Results Before and After the Activity

The results before and after the activity at Figure 1 showed a significant improvement in the skills of GAPOKWATAN Lumbung Rasa members after participating in mentoring and training on roselle kombucha production. Before the activity, the level of understanding of hygienic processing was only around 30%, the ability to apply fermentation techniques was very low at around 20%, product packaging quality was still basic with a score of 25%, the use of appropriate technology only reached 15%, and product diversification was limited to dried roselle tea at only 10%. After technology transfer, mentoring, and sustainable practices, there was a significant improvement in almost all aspects. Understanding of hygienic processing increased to 80%, fermentation skills reached 75%, packaging quality increased to 70%, the use of appropriate technology increased sharply to 85%, and product diversification developed with the introduction of roselle kombucha, reaching 65%. Overall, these data indicate substantial improvements in knowledge and skills, reflecting the success of implementing innovations to enhance the capacity of community groups.

The kombucha production process begins with preparing dried roselle petals, which are infused in hot water to extract their color and bioactive compounds. After adding sugar as a fermentation substrate, the mixture is cooled and inoculated with Symbiotic Culture of Bacteria and Yeast (SCOBY). Fermentation is carried out for 7-10 days at room temperature. During fermentation, the sugar content decreases as it is converted into organic acids and carbon dioxide, producing a sweet and sour drink with natural carbonation (Pinto et al., 2022). These changes enhance the sensory quality of kombucha, resulting in a fresh taste, bright red color, and unique aroma that differs from regular roselle tea (Hidayanti et al., 2014; Suhartatik et al., 2009). After fermentation, kombucha is filtered, bottled in sterilized containers, and packaged with labels designed during the program. Partners are trained in hygienic bottling, proper storage, and branding strategies to ensure safety and consumer appeal. Fermentation leads to modifications in the bioactive compounds and physical properties of the beverage, characterized by an increase in acetic acid content, a reduction in sugar content, and the formation of carbon dioxide that provides natural carbonation (Khamidah et al., 2020; Yustin et al., 2025). This change also improves the sensory qualities of kombucha, including taste, aroma, and color, making it more appealing to consumers than regular roselle tea. The fermentation process used does not produce hazardous waste, thereby minimizing the risk of environmental pollution. Roselle kombucha production can be categorized as a relatively environmentally friendly activity, as it utilizes locally available raw materials in Pitra Village without requiring large-scale agricultural intensification.

Figure 2. Symbiotic Culture of Bacteria and Yeast (SCOBY)

Processing and diversifying roselle through fermentation into kombucha is an important strategy for increasing the added value of local horticultural products. Before the community service program, the use of roselle in Pitra Village was limited to dried tea, which has relatively low economic value. Product diversification through kombucha fermentation not only increases product competitiveness but also supports the sustainability of roselle farming. The fermentation process in kombucha produces bioactive compounds such as organic acids, vitamins, and enzymes that provide health benefits to consumers. Roselle kombucha has shown beneficial properties for improving human health (Darmawan et al., 2018). Antibacterial Properties Roselle kombucha has shown significant antibacterial activity, especially against Escherichia, with the most effective inhibition observed after 15 days of fermentation. This beverage has antioxidant and antihypercholesterolemic effects, as it is rich in antioxidants (Sutthiphatkul et al., 2023). Although these antioxidants decrease slightly during fermentation, they remain effective. It also significantly reduces cholesterol levels, with a 56% reduction observed in one study (Darmawan et al., 2018). Evidence from animal studies shows that roselle kombucha is able to maintain standard blood profiles, indicating its potential role in supporting human blood health.

Figure 3. Fermentation Process

The innovation of processing roselle into kombucha has strengthened social cohesion in the community through collective work in production and marketing. This change has also enhanced the role and position of women as key drivers of innovation, while encouraging a more open mindset towards new technologies and business opportunities. Thus, the social dynamics of the village have transformed into a more collaborative and inclusive community oriented towards sustainable agribusiness. Program results show a significant increase in the technical skills and knowledge of partner groups. Members of GAPOKWATAN Lumbung Rasa have successfully implemented Good Manufacturing Practices (GMP) and Sanitation Standard Operating Procedures (SSOP) in kombucha processing, ensuring that products are more hygienic and meet quality standards. In addition, the use of fermentation equipment, packaging tools, and training in product labeling has effectively increased the attractiveness and market competitiveness of the products. From an economic perspective, this innovation creates opportunities to increase the income of partner groups. Roselle kombucha can be sold at a higher price than dried tea because it offers a unique flavor profile and health benefits. Based on monitoring results, the group has been able to produce kombucha regularly with a capacity of 10-15 liters per week. The innovation of processing roselle into kombucha has strengthened social cohesion in the community through collective work in production and marketing. This change has also elevated the role and position of women as key drivers of innovation, while encouraging a more open mindset toward new technologies and business opportunities. As a result, the social dynamics of the village have shifted toward a more collaborative and inclusive community focused on sustainable agribusiness.

Figure 4. Community Participation in Roselle Kombucha Production

The program results show a significant improvement in the technical skills and knowledge of the partner group. Members of GAPOKWATAN Lumbung Rasa have successfully implemented Good Manufacturing Practices (GMP) and Sanitation Standard Operating Procedures (SSOP) in kombucha processing, ensuring that the products are more hygienic and meet quality standards. In addition, the use of fermentation equipment, packaging tools, and training in product labeling has effectively increased the attractiveness and market competitiveness of the product. From an

economic perspective, this innovation has created opportunities to increase the partner group's income. Roselle kombucha can be sold at a higher price than dried tea because it offers a unique flavor profile and health benefits. Based on monitoring results, the group has been able to produce kombucha regularly with a capacity of 10-15 liters per week. With an average selling price of Rp 20,000–25,000 per 250 ml bottle, partners can achieve an increase in revenue of up to 40–50% compared to their previous income. However, local market dynamics show that kombucha products are not only produced from roselle but also from other ingredients such as green tea, black tea, and various herbal plants. This situation creates a relatively high level of competition in terms of price, quality, and marketing strategy. Therefore, the partner group must continue to improve product differentiation by leveraging the comparative advantage of roselle as a local commodity, strengthening its branding as a product unique to Pitra Village, and optimizing digital marketing. This strategy will enable GAPOKWATAN Lumbung Rasa to maintain its competitive advantage amid increasing market competition.

This program also has a significant social impact because all members, especially women farmers, actively participate in every stage of the program. The majority of GAPOKWATAN Lumbung Rasa members are women. Their involvement in Roselle kombucha production not only strengthens their technical capacity but also increases their economic contribution at both the household and community levels. Women are no longer positioned as merely additional labor in the agricultural sector; instead, they have become key drivers of innovation and entrepreneurs capable of making strategic decisions related to production and marketing. This shift has elevated the social status of women and promoted gender empowerment, contributing to more inclusive and sustainable rural economic development.

The success of this program also supports the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger) and SDG 3 (Good Health and Well-being), by promoting functional food products based on local resources. With the innovation of processing roselle into kombucha, Pitra Village has the potential to become a center for innovative herbal beverages that are competitive not only at the local level but also in broader markets, particularly in supporting culinary tourism in the Jatiluwih area. Therefore, the sustainability of this program must be supported by product legality (PIRT, BPOM, and halal certification), flavor variant development, and digital marketing strategies to expand the distribution network. Product legality is a crucial factor in ensuring the sustainability of the roselle kombucha development program. Official certifications such as PIRT, BPOM, and halal not only provide legal recognition of product safety and quality but also serve as important prerequisites for entering modern markets and expanding distribution networks, including the tourism sector. The certification process involves several stages, including compliance with technical production standards in line with Good Manufacturing Practices (GMP) and Sanitation Standard Operating Procedures (SSOP), preparation of complete administrative documents, and evaluation by the relevant authorities.

Conclusion

The community empowerment program through the innovation of processing rosella into kombucha at GAPOKWATAN Lumbung Rasa, Pitra Village, has successfully improved the technical, economic, and social capacity of group members. The training results showed significant improvements in hygienic processing, fermentation skills, packaging quality, and rosella-based product diversification. This innovation not only produced functional beverages with added economic value, but also strengthened social cohesion and enhanced the role of women as key drivers of innovation. From an environmental perspective, the rosella kombucha production process is sustainable because it utilizes local raw materials without producing hazardous waste. In addition, this program contributes to the achievement of the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger) and SDG 3 (Good Health and Well-being). To maintain sustainability, the group needs to strengthen the legality of the product, market differentiation, and digital marketing strategies so that rosella kombucha can become a competitive flagship product in the local, regional, and national markets.

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