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Implementation of process technology and diversification of Astiri Oil products to improve community economy

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ABSTRACT

Jatijejer Village, located between the slopes of Mount Penanggungan and Mount Welirang, has significant potential for cultivating aromatic plants, particularly lemongrass (Cymbopogon citratus) and citronella (Cymbopogon nardus). These plants are sources of essential oils with various benefits, including uses in aromatherapy, antibacterial, and anti-inflammatory applications, and are widely utilized in the cosmetics and healthcare industries. Despite this potential, the community of Jatijejer Village previously only utilized lemongrass as raw material, yielding suboptimal economic value and welfare improvement. This community service program aims to enhance the welfare of Jatijejer Village through the production and diversification of essential oil-based products. Activities included training in steam distillation techniques, quality measurement of essential oils, and the development of derivative products such as inhalers and diffusers. Evaluation results showed a significant improvement in participants' knowledge and skills. The average pre-test score of 58.4 percent increased to 97.2 percent in the post-test. Additionally, the essential oils produced were successfully developed into value-added products, such as inhalers and diffusers, which have begun to be marketed locally. Solid waste from the distillation process was also utilized as organic fertilizer, reinforcing the program's sustainability. This training effectively improved the skills, income, and economic independence of the Jatijejer Village community.

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1. INTRODUCTION

Jatijejer Village, strategically located between the slopes of Mount Penanggungan and Mount Welirang in Trawas District, Mojokerto Regency, East Java, has great potential for cultivating aromatic plants, particularly kitchen lemongrass (*Cymbopogon citratus*) and citronella (*Cymbopogon nardus*). The fertile soil and ideal agro-climatic conditions make the village suitable for growing these plants, which can be processed into high-value essential oils (Fradana et al., 2020). The essential oils from these two types of lemongrass are rich in active compounds like citral, geraniol, citronellal, and citronellol, which offer various benefits, including aromatherapy, insect repellence, anti-inflammatory, antibacterial, and antifungal properties (Mahmud et al., 2022; Ibrahim et al., 2021).

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Essential oils have vast market potential, both domestically and internationally, especially in the cosmetic, skincare, and health industries (Azizah et al., 2022; Taufiq & Khatimah, 2023). The demand for derivative products, such as inhalers and diffusers, continues to rise because they offer not only health benefits but also aesthetic aspects. These products are widely used for aromatherapy to create a comfortable and soothing atmosphere, presenting a significant opportunity for the people of Jatijejer Village to develop essential oil-based businesses (Mariana & Noveriza, 2013).

However, despite its great potential, the community in Jatijejer Village still faces several challenges in optimally developing the essential oil industry. Key challenges include a lack of knowledge about efficient distillation techniques and the quality standards required to meet market demands (Sukarta, 2023; Wijayati, 2023). Many farmers still use traditional distillation methods that result in inconsistent oil quality (Amarullah, 2023; Pratama et al., 2022). These traditional methods typically involve simple distillation equipment made from drums or metal tanks without proper temperature and pressure control. The distillation process involves boiling raw materials in water until essential oil vapors form, but without a precise control system, excessive burning or insufficient heating often occurs. This can lead to the degradation of key chemical compounds in the essential oil or the loss of valuable volatile components. Inconsistent quality indicators of essential oils include variations in oil yield, overly dark colors from overheating, atypical aromas due to uneven evaporation of key compounds, and levels of key components like citral or citronellal not meeting quality standards. The oils produced often fail to meet Indonesian National Standards (ISN) or international market requirements, resulting in low market value. Modern distillation technology needs to be implemented to produce essential oils with more stable quality and in line with standards.

Through a community service program, training and mentoring in the application of process technologies and product diversification are strategic steps to address the low economic value of essential oil products in Jatijejer Village. This solution begins with the application of modern distillation technologies, such as steam distillation with more precise temperature and pressure control systems. This technology has been shown to improve oil yield and maintain the stability of essential oil quality, including key parameters like citral and citronellal content, thus meeting both national and international standards (Rasydy et al., 2020). In addition to process improvements, product diversification is also a key focus to increase economic value. Derivative products, such as inhalers, diffusers, aromatherapy candles, and herbal soaps, are being developed to meet a wider market demand. This diversification not only adds value but also creates new, more profitable market opportunities, particularly in the health and lifestyle sectors (Supriadi et al., 2021).

The training not only covers technical aspects of production but also strengthens managerial capacity and marketing strategies to ensure business sustainability. With this approach, the people of Jatijejer Village are expected to create an independent and sustainable economic ecosystem, no longer relying on the sale of raw materials but also managing high-quality processed products that are competitive in local and national markets. This effort aligns with research showing that the application of innovative technologies and product diversification is key to improving competitiveness and the welfare of communities based on local potential.

The main goal of this community service activity is to increase the economic value of the essential oils produced by the people of Jatijejer Village through the application of more modern process technologies and diversification of essential oil-based products. With comprehensive training and mentoring, it is hoped that the community will be able to produce high-quality essential oils that meet market standards while also creating value-added derivative products, such as inhalers and diffusers. In addition to enhancing technical and managerial skills, this program also aims to promote economic independence through sustainable management of local resources.

2. METHODS

Activity Design

This community service activity was carried out in Jatijejer Village, Trawas District, Mojokerto Regency, East Java, on September 5, 2024, and November 10, 2024. The village has significant potential for cultivating citronella (*Cymbopogon nardus*) and kitchen lemongrass (*Cymbopogon citratus*), which have not been optimally processed by the local community. The partners involved include representatives from farmer groups, the PKK (Family Welfare Movement), BUMDes (Village-Owned Enterprises), and village officials of Jatijejer. To support the implementation of this activity, equipment such as small and large-scale steam distillation units, refractometers for measuring refractive indices, and materials for making derivative essential oil products like inhalers and diffusers have been prepared.

Program Implementation Method

The method used in this program is training and mentoring, designed to provide both theoretical understanding and practical skills to the community. The training began with a presentation of material divided into two parts. The first part covered steam distillation techniques for essential oil production, including how to use distillation equipment and measure oil quality with a refractometer. The second part focused on the diversification of essential oil-based products, such as making inhalers and diffusers, from formulation to packaging.

Mentoring was provided to ensure participants could apply the techniques they had learned. The indicators of success for the program include the improvement in pre-test and post-test scores, which demonstrate an increase in knowledge, as well as quantitative data such as the increase in essential oil yield and revenue from the sales of derivative products.

Schedule and Phases of Program Implementation

Table 1 is the schedule and phases of the community service program in Jatijejer Village.

Table 1. Program implementation schedule

Essential Oil Production Training	
Purpose	Teaches steam distillation techniques to produce high-quality essential oils.
Description	The material includes how to use small and large-scale distillation equipment, as well as measuring oil quality with a refractometer.
Implementation date	September 5, 2024
Product Diversification Training	
Purpose	Developing skills in making essential oil-based derivative products.
Description	Training includes making inhalers and diffusers, with guidance on formulation, production, and product packaging.
Implementation date	November 10, 2024
Program Evaluation	
Purpose	Measuring the impact of activities on the improvement of participants' knowledge, skills, and income.
Description	Evaluation is carried out through surveys and interviews to assess the effectiveness of the training and formulate recommendations for future program development,
Implementation date	September 5 and November 10, 2024

3. RESULTS AND DISCUSSION

Result

Essential oil production training

Steam distillation training was carried out according to the designed method. In the initial stage, the material was presented on various essential oil extraction techniques. Based on the literature (Chemat & Boutekedjiret, 2015), there are several main distillation techniques, presented in table 2. Based on the evaluation of the characteristics of raw materials and production scale, the steam distillation technique was chosen as the best method for extracting essential oils from citronella and lemongrass. This process was implemented using small and large scale steam distillation devices. The steam distillation techniques taught were on three scales, namely laboratory scale, medium scale and large scale. In general, the steam distillation process can be seen in the flow diagram presented in Figure 1.

Table 2. Various essential oil extraction techniques

Essential oil extraction technique	Description
Water Distillation	This process involves soaking the raw material in water which is then heated to boiling. The steam formed carries the essential oil and is condensed into a liquid. This technique is suitable for raw materials that are easily soluble in water but require a longer extraction time.
Steam-water distillation	This technique combines the use of boiling water and steam to heat the raw material indirectly. This process prevents the degradation of active compounds due to excessive heat.
Direct Steam Distillation	This technique involves the raw material being heated directly by steam produced by the boiler. This technique can prevent the degradation of active compounds. This method is also more efficient because it does not come into direct contact with water, resulting in purer oils.
Enfleurage Method	This technique uses fat solvents to extract essential oils from flowers.
Cold Compression	This technique is used for raw materials such as oranges that are not heat resistant, this technique involves mechanical pressure to remove essential oils.

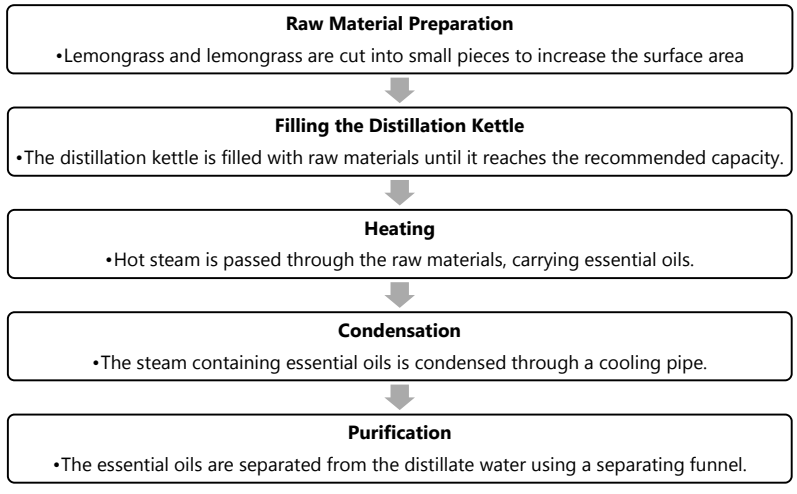

Figure 1. Steam distillation process flow diagram

Participants were also taught simple measurement of essential oil quality using a refractometer to measure the refractive index which is one of the standard quality parameters based on SNI 06-3941-1995 and the Indonesian Herbal Pharmacopoeia, second edition (Kementerian Kesehatan Republik Indonesia, 2017). In addition to the refractive index, several parameters that are SNI requirements include organoleptic test results and volume and yield tests. Parameters observed in organoleptic tests include color, aroma and clarity of essential oils. Good essential oils are bright yellow with a distinctive lemongrass aroma. The yield of good essential oils generally ranges from 0.5 - 2 percent. After the material is provided, participants are trained to produce essential oils from kitchen lemongrass and fragrant lemongrass (Figure 2). This training includes checking the quality of essential oils using parameters that refer to the Indonesian Herbal Pharmacopoeia, second edition (Kementerian Kesehatan Republik Indonesia, 2017).

Figure 2. Essential oil production training activities: (a) Use of steam distillation; (b) Separation of essential oils; (c) Use of refractometer

Product diversification training

In the second stage, training was conducted on product diversification from essential oils, namely inhalers and diffusers. The presentation of the material was carried out by the community service team. Participants were taught how to make essential oil inhalers and essential oil diffusers to increase the selling price of the essential oil products produced (Figure 3). The process of making inhalers and diffusers can be seen in Figure 4. To improve the sustainability of this program, participants were divided into ten groups tasked with marketing inhaler and diffuser products to various target markets at the sub-district level. From this activity, the enthusiasm of the participants was seen and this showed that their skills and creativity had increased.

Figure 3. Essential oil product diversification training activities, namely inhalers and diffusers

Evaluation of training results

Pre-test and post-test were used to measure participants' understanding. Table 1 shows significant improvement in technical knowledge and skills. The average pre-test score of 58.4 percent increased to 97.2 percent after the training.

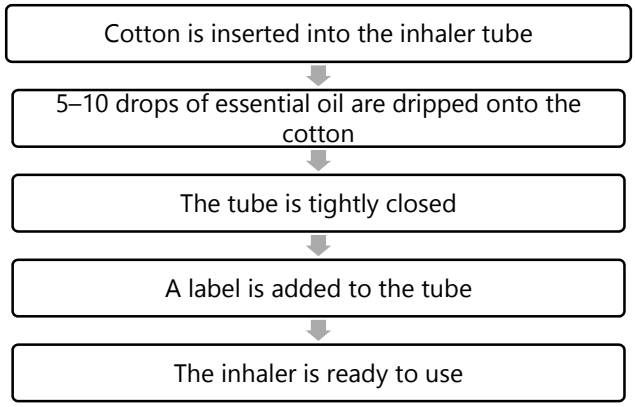

Figure 4. Flowchart of inhaler manufacturing process

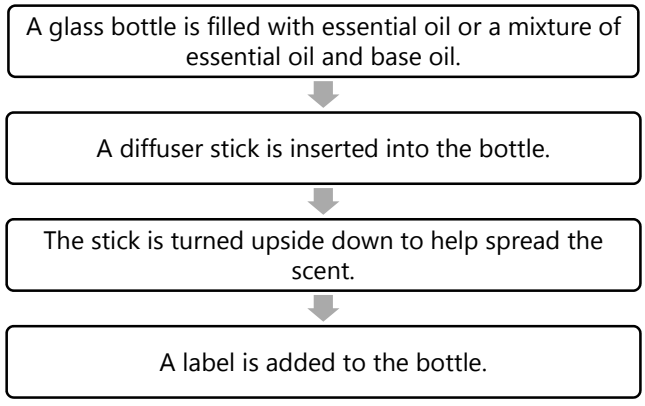

Figure 5. Diffuser manufacturing process flow chart

Table 2. Topic parameters measured in the pre-test and post-test

Topics	Pre-Test Score (%)	Post-Test Score (%)
Knowledge of the working principle of steam distillation, equipment used, and steps in essential oil production.	56	98
Knowledge of how to operate small and large scale distillation equipment to produce high quality essential oils.	60	96
Use of refractometers to measure refractive index and understand essential oil quality standards according to SNI.	58	96
Practical steps in designing and producing essential oil-based inhalers and diffusers.	60	97
Attractive packaging techniques and marketing strategies for inhaler and diffuser products in local and online markets.	58	97
Average	**58.4**	**97.2**

Results of Implementation of Appropriate Technology

A total of 250 bottles of essential oil (100 mL/bottle) have been produced and sold at a price of IDR 15,000 per bottle. Inhaler and diffuser products are marketed at the sub-district level and national

exhibitions Figure 3. By November 2024, additional income from derivative products reached IDR 2,500,000.

Figure 6. Exhibition of essential oil products, inhalers, and diffusers

Discussion

The optimization of essential oil production in Jatijejer Village aims to enhance the community's economic independence and establish Jatijejer as the first essential oil village in East Java. Through pre-test and post-test evaluations, a significant improvement in participants' understanding of distillation techniques and product diversification was observed. Before the training, the average pre-test score was only 58.4 percent, indicating a basic understanding of topics such as distillation equipment operation and refractometer usage. After the training, the average post-test score increased dramatically to 97.2 percent, reflecting nearly perfect comprehension of all topics taught. This improvement confirms that the training successfully enhanced participants' knowledge and skills, particularly in technical aspects like distillation processes, oil quality measurement, and the production and marketing of essential oil-based products like inhalers and diffusers. This aligns with other studies showing that entrepreneurship and digital marketing training can enhance community skills in business management (Nugrahaningsih et al., 2021).

Essential oil products are not only sold in pure oil form but have also been developed into inhalers and diffusers. Since mid-September 2024, essential oils have been marketed at the sub-district level and showcased at exhibitions attended by the Ministry of Tourism and Creative Economy of Indonesia. A total of 250 bottles of 100 mL essential oil have been produced and sold at IDR 15,000 per bottle. Simple inhalers are made by dripping essential oil onto cotton in an inhaler tube, while diffusers only require a few drops of essential oil on the diffuser device. In early November, a product exhibition of essential oil derivatives was held.

This activity has provided direct benefits to the community of Jatijejer Village, including skills enhancement in steam distillation and essential oil product diversification, increased income through the sale of essential oils and their derivatives, and waste reduction by utilizing distillation residue as organic fertilizer. For example, essential oil production reached 10 liters per month, a figure that previously did not exist. Derivative products provide an additional income of up to IDR 2,500,000 per month, demonstrating a significant economic impact.

In terms of utilizing harvests, all parts of the lemongrass plant grown by local farmers can be used without waste. The lemongrass stalks can be sold in the market for culinary purposes, its leaves processed into essential oils and their derivatives, and distillation by-products with a lower grade (C) can be used for products like natural pesticides and floor cleaners. Solid waste from distillation can also be utilized as organic fertilizer. This waste utilization strengthens the sustainability aspect of the program.

After the inhaler production training, the community was given the opportunity to try their products. Based on direct interviews, the use of essential oil-based inhalers showed a positive impact on the community, including a reduction in smoking frequency after two weeks of use. The inhaler and diffuser products also offer other health benefits, such as stress relief and improving indoor air quality.

This program successfully improved the community's skills, knowledge, and income. Participants, who initially lacked production skills, were able to create inhalers and diffusers. The increased profits from product sales demonstrate the potential for sustainable economic development. The results of this community service program show an increase in the community's economy. Initially, no essential oil products were produced, but after the program's implementation, the community is now producing 10 liters of essential oil per month. Additionally, the derivative products have contributed an additional income of up to IDR 2,500,000 by November. Jatijejer Village has taken its first steps toward economic independence by optimizing its local potential. The competition between groups in packaging and marketing products also demonstrates a high level of sustainability. These results show that community service programs can encourage villages to become centers of innovation based on natural resources, while simultaneously improving the community's welfare sustainably. Additional essential oil-based products will be designed for future development agendas.

4. CONCLUSION AND RECOMMENDATIONS

The community service program in Jatijejer Village successfully produced essential oils and diversified essential oil-based products from kitchen lemongrass (Cymbopogon citratus) and aromatic lemongrass (Cymbopogon nardus). Through training, the community not only learned to produce high-quality essential oils but also developed derivative products such as inhalers and diffusers, which can increase the market value of lemongrass. Evaluation results showed a significant improvement in participants' understanding and skills, reflected in the increase of the average pre-test score from 58.4 percent to 97.2 percent in the post-test. The results of this community service program also demonstrated an economic improvement, with the production of 10 liters of essential oil per month, along with derivative products, generating additional income of up to IDR 2,500,000 per month. This program is sustainable, and after field learning and intensive training, the village will continue to receive guidance in developing Jatijejer into the first essential oil village in East Java.

For future community service programs, it is recommended to include more intensive digital marketing training. Introducing e-commerce and social media as marketing platforms can help expand the market reach of essential oils and their derivative products, such as inhalers and diffusers. Furthermore, it is necessary to conduct studies on the potential development of new products based on essential oils, in line with market demands, such as aromatherapy candles or herbal soaps. Collaboration with other institutions, both academic and industrial, is also crucial to support technological innovation and access to a broader market. Ongoing monitoring should be conducted to ensure the sustainability of the program and consistent capacity-building for the community.

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