Development of Clove Oil Processing Installation to Comply with Indonesian Nasional Standard (SNI) in Gerbosari Village

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ABSTRACT

One important oil center is in the Samigaluh sub-district, Kulon Progo, Yogyakarta, as there are several small business groups, and most produce clove oil. Gerbosari village, one of the villages in the Samigaluh sub-district, is one of Indonesia's largest clove oil producers. Yet, the development is not significant enough as distillation technology is still considered minimal and less profitable. The problem revolving around clove oil production for small businesses is that the produced oil's quality is deficient. A notable amount of iron (Fe) can still be found in the oil, resulting in a relatively low selling price. Community service was suggested based on applying appropriate technology targeting the clove oil refining actors or industry on the Medium, Small, and Micro Enterprises (MSME) scale in Gerbosari, namely MSME Surya Wulan, to obtain export quality clove oil eligible to *Standar Nasional Indonesia* (SNI) or National Standards of Indonesia. This year's community empowerment activities proceeded the previous year when the zeolite adsorbent was made, which was done at CV Fruitanol Energy and has undergone physicochemical characterization in FMIPA UGM's chemistry laboratory. Zeolite adsorbents were applied for the clove oil's purification process and then tested for quality to determine compliance with SNI standards and carry out chemical and physical properties characterization. This year's community empowerment focused on installing and applying clove oil purification technology using an energy-efficient distillation. Clove oil production's business feasibility study from this technology application was also carried out to describe the market's production potential, demand, and continuity. The results were summarized in an integrated module to transfer knowledge to MSME Surya Wulan. Furthermore, coaching will be carried out to MSME Surya Wulan to produce clove oils independently and sustainably.

Keywords: Clove Oil, Distillation, Gerbosari, MSME

1 Introduction

Indonesia is one of the countries that export essential oils generated from clove, eucalyptus, patchouli, nutmeg, sandalwood, and ylang. According to Lutfi (2013), essential oils, also known as volatile oils, come from the plant parts' steam distillation, such as leaves, flowers, stems, or seeds [1]. They can evaporate quickly at room temperature (20-23 degrees Celsius) and have a distinctive odor that matches the plants used [2]. Besides being widely used in various industrial fields, they are also used in aromatherapy [3].
Clove (*Syzygium aromaticum*) can produce essential oils through distillation from its leaves (2-3%), stems (6%), and flowers (21.3%) [4]. The oil's physical properties include color, refractive index, odor, density, components, and chemical compounds. The quality depends on the plant's type, origin, method, and analysis [5]. The following Table 1 [6] [7] states the clove oil quality standards.

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Table 1: *Clove Oil Quality Standard*

Characteristics	SNI 06-2387-2006	EOA Standards
Eugenol content (%)	Min. 78	84-88
Bias Index (^{n}D20)	1.5280 – 1.5350	1.5310 – 1.5350
Color	Yellow – dark brown	Pale yellow

Clove oil contains chemical compounds: eugenol (70-90%), eugenol acetate, and n β-caryophyllene [8]. Eugenol is needed in the cosmetic, pharmaceutical, food, beverage, cigarette, pesticide, and chemical industries [9] [10]. Clove oil's world market demand tends to increase, even in the Covid-19 pandemic situation, thus encouraging the essential oil business units' growth and development, especially in Indonesia. Clove leaves that have been processed into oils can be valuable economically, as clove leaves cost about IDR2,500 per kilogram while clove oils' cost start from IDR135,000 per kilogram. Clove oil's price for export reaches IDR290,000-500,000 per kilogram, depending on the eugenol content. The oil yield from clove leaf distillation could get 1-5% [10] [11].

Indonesia supplies more than 60% of the world's clove oil needs yearly, equivalent to about 1317 tons [1]. However, most of Indonesia's clove oil export prices are still determined by other countries due to competition in the product's quality, where Indonesia's clove oil quality is still considered below the standards [12]. More than 90% of Indonesia's exported clove oils are in crude oil, generally produced by refining industries managed by clove farmers and MSME actors [1]. Samigaluh district, as one of the largest essential oil producing center in Yogyakarta, are also experiencing similar problems with MSME-based business groups--which they cannot set a price for the clove oil they produce since the oil's quantity and quality are considered not good enough. Moreover, clove oil for export has a relatively low selling price (around IDR230,000 per kilogram) due to the low level of eugenol [13] as well as containing water and impurities (metal iron).

The clove oil's quality exported by MSMEs in Samigaluh village is quite apprehensive as it is below the SNI quality standard; the color (dark brown) and the containing impurities may come from the materials used and the processing equipment. Most MSMEs in the village produce clove oil using distillation apparatus made from used asphalt container drums made of iron and aluminum vessels. This situation has encouraged efforts and development in the clove oil processing activities regarding improving produced clove oils' quantity and quality to comply with the SNI standards in Samigaluh's MSMEs, especially in the Gerbosari village. The oil quality standards' increment predictably can boost the selling value and support the national economy. Community service activities that offer appropriate technology are expected to be able to provide practical solutions for clove oil's refining business actors who require technological breakthroughs that are notably cheaper, more effective, and more efficient.

Our activity offered the energy-efficient distiller installation of stainless steel with a heat insulator and a clove oil refinement technology derived from CaO-Zeolite composites. A distillation apparatus with a kettle made from stainless steel can produce good-quality essential oils. Besides, CaO-Zeolite can reduce water content and remove impurities, thus giving added value to the final product. A business feasibility analysis for clove oil production using the technology ran is to describe market potential, demand, and production continuity. In addition, the market's ability to absorb the product at the right selling price can positively affect producers.

These community empowerment activities continued the previous year's activities which produced the Cao-Zeolite adsorbent at CV Fruitanol Energy. This adsorbent has undergone Physico-chemical tests at the FMIPA UGM's Physical Chemistry Laboratory, which include FTIR, XRD, XRE, SEM, TEM, SAA, TGA, and AAS analyses. Zeolite adsorbents were applied for the clove oil's purification process and then tested

for quality to determine compliance with SNI standards and carry out chemical and physical properties characterization. Our recent empowerment activities focused on installing and applying a clove oil refining technology using an industrial-scale energy-efficient distiller made from stainless steel at CV Fruitanol Energy with a capacity of up to 15 kilograms of clove leaves.

2 Research Methodology

These activities' technical implementation can be broadly divided into four stages.

2.1 Preparation

At this stage, the researcher prepared the equipment and materials needed during community service activities, using existing facilities at the FMIPA UGM's Physical Chemistry Laboratory, CV Fruitanol Energy, and MSME Surya Wulan engaged in essential oil refining in Gerbosari village.

2.2 Making and Testing the Technology Package

a. Manufacturing patchouli oil-refining equipment from stainless steel with a capacity of 10 L
b. Preparation of CaO-Zeolite
c. The zeolite and specific ratio of CaO obtained from CV Fruitanol Energy were put into the hydrothermal reactor at 120 °C for the reaction process for 1 hour. After this process, the product was filtered, dried, and prepared for the next stage. CaO-Zeolite's characterization, which included physico-chemical tests, would be carried out in the FMIPA UGM's Physical Chemistry Laboratory.
d. The author used CaO-Zeolite to refine the clove oil from what was produced in the previous stage. A total of 5 L of crude clove oil was mixed with 100 grams of adsorbent and stirred for 5 hours. The mixture was then filtered or centrifuged.
e. The characterization of iron content, acidity number, eugenol content, refractive index, solubility in ethanol, specific gravity, and other parameters that serve as benchmarks for the quality requirements of SNI 06-2387-2006 of clove oil produced in the previous stage was conducted. SNI requires the product to have a yellow–dark brown color; a distinctive smell of clove oil; a density of 1.025–1.049; a refractive index of 1.528-1.535; solubility in ethanol 70%; a value of 1:2; a high clarity; and a minimum total eugenol content of 78%.

2.3 Application of technology and its evaluation

This stage requires technology transfer to the Surya Wulan MSME, Gerbosari village, Samigaluh, Kulon Progo. Direct coaching would occur 5-6 times to the local community.

3 Results and Discussion

The development of the Gerbosari village clove oil processing installation was completed as planned until the end of the activity in October 2022 (Table 2). The clove oil refining device was handed over to MSME Surya Wulan and was tested by refining the clove oil resulting from a distillation process. Figure 1 shows the process of clove oil refinement installation and testing and the simple device that can be directly operated without special training. In this device, the oil poured is sucked in using a pump and goes down through the adsorbent. The cleared oil is then collected in a heat-resistant glass. This device can refine 15 L of distilled clove oil in less than 1 hour.

Clove oil resulting from the refining process shows that the refined clove oil is cleaner than before. This shows that the refining process using adsorbents has been done successfully. However, refined clove oil is hoped to have a higher purity to increase marketability.

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Table 2: *Activities*

Activity	Time Occurred	Description
Coordination with MSME management (Surya Wulan) in Gerbosari Village	May 2022	It was carried out by the Team jointly with the MSME management team (Surya Wulan) in Gerbosari Village regarding the preparation and implementation of activities, meeting schedules, and division of tasks. This activity is carried out both offline and online.
Activities implementation preparation in the MSME Surya Wulan's physical chemistry laboratory	May 2022	An online meeting with all team members discussed the activities implementation. Offline activities at CV Fruitanol Energy related to the tools and materials preparation for clove oil refining adsorbent materials manufacture. The resulting adsorbent was tested and analyzed at the FMIPA UGM's physical chemistry laboratory. Offline activities implementation at MSME Surya Wulan related to installing and applying clove oil refining technology's preparation.
Clove oil refining adsorbent materials manufacture and test	May to July 2022	Making adsorbents for clove oil refining, testing the materials' physico-chemical properties and their effectiveness for the clove oil refining process at CV Fruitanol Energy and the FMIPA UGM's Physical Chemistry Laboratory.
The clove oil's distillation and refinement process using an adsorbent	July to October 2022	The simulation process determined the adsorbent's effectiveness in the clove oil refining process. A quality test was then conducted to determine the product's compliance with the SNI standards. The quality test includes iron content, acidity number, and other parameters, which are the benchmarks for the quality requirements set in SNI 06-2387-2006.
Assessing the product's business feasibility resulted in the technology application	June to October 2022	A business feasibility analysis was conducted by looking at the costs incurred and the quality and feasibility tests of processed clove oil, followed by an economic analysis of clove oil production.
Installation and application of the technology developed at MSME Surya Wulan	August to October 2022	The adsorbent was applied to the clove oil refining installation, followed by demonstrations and coaching with MSME Surya Wulan as a technology transfer process.
Report preparation	June to October 2022	Report preparation related to the studies' results and business strategies' development in the form of videos, SNI-standard clove oil manufacturing technology package modules, scientific articles for publication in community service journals, and final reports on community service activities.

Figure 1: *The clove oil purification process uses a clove oil purification tool at Surya Wulan MSME*

4 Conclusions

The Physical Chemistry Laboratory community service activities in 2022 have been successfully done. Installing the clove oil refining device has been successfully carried out. The trial results show that the refined clove oil has a brighter color, thus higher quality than the unrefined one.

5 Declarations

5.1 Acknowledgments

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5.2 Publisher's Note

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