

Optimization of lemongrass cultivation into essential oil in Tunggularum, Wonokerto

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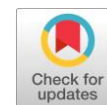
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ABSTRACT

The empowerment of the community in Tunggularum, Wonokerto, aims to optimize lemongrass (*Cymbopogon citratus*) cultivation into essential oil products through community-based training and practical skills development. Lemongrass is widely cultivated in the area but is underutilized due to limited knowledge of its potential economic value, particularly in essential oil production. This community service project focused on addressing this gap through two primary activities: a socialization session on the essential oil distillation process and hands-on training in the operation of distillation equipment. The project involved 20–25 local participants, predominantly women, who attended both the theoretical and practical sessions. The results showed significant improvements in the participants' knowledge and skills. Over 70% of participants reported feeling more capable of managing the local lemongrass resources and demonstrated an enhanced understanding of the distillation process. The training also fostered new skills in operating distillation equipment, which further encouraged the participants to explore the business potential of lemongrass essential oil production.



KEYWORDS

Community empowerment
Distillation
Essential oil
Lemongrass
Tunggularum
Wonokerto



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1. Introduction

In 2023, the agricultural sector contributed 12.53% to the total Gross Domestic Product (GDP), ranking third after the manufacturing sector (18.67%) and trade (12.94%). This figure shows a slight increase from the previous year's percentage (12.40%) [1]. Of this percentage, 1.44% is attributed to horticultural agriculture, including lemongrass cultivation. Agriculture in Indonesia, as one of the largest sectors, is widespread throughout various regions [2]. One of the agricultural areas is the Special Region of Yogyakarta, specifically in Kalurahan Wonokerto, Kapanewon Turi, Sleman Regency. The majority of the Padukuhan Tunggularum community engages in farming and gardening staple crops such as rice and corn. Additionally, many farmers also cultivate horticultural plants such as lemongrass (*Cymbopogon citratus*) in their yards or vacant lots [3]–[5], although it is not yet extensively maintained [6]. *Cymbopogon citratus*, or culinary lemongrass, can grow in nearly all regions of Indonesia [7], from lowlands to highlands, in various types of soil and climates, and can thrive with minimal care [8], [9]. Conversely, Indonesia was a major exporter of lemongrass essential oil before World War II, but now China is the leading producer [10], [11]. Global demand for lemongrass essential oil has been increasing year by year, yet Indonesia meets only about 10% of this demand. Therefore, initiating essential oil distillation industries is crucial [12]–[15].

Based on discussions with a member of the Kalurahan Wonokerto government, lemongrass is considered the most promising agricultural commodity for cultivation in the Wonokerto area [16], [17]. Efforts to add economic value to lemongrass include distilling it into essential oil. A random survey following this discussion was conducted with several residents of Kelurahan Wonokerto, coordinated by Padukuhan Tunggularum as show in Fig. 1. The survey results, shown in Fig. 2 and Fig. 3, reveal that residents' knowledge of lemongrass derivative products is limited to culinary uses and herbal drinks, while their understanding of the essential oil distillation process remains minimal.



Fig. 1. Discussion photo with Kalurahan Wonokerto government member

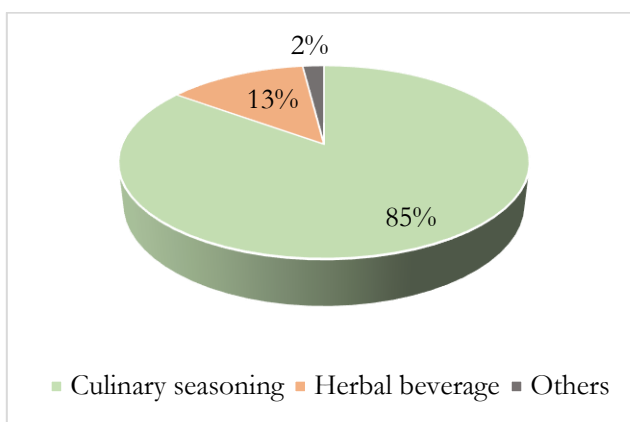


Fig. 2. Survey results on knowledge of lemongrass derivative products

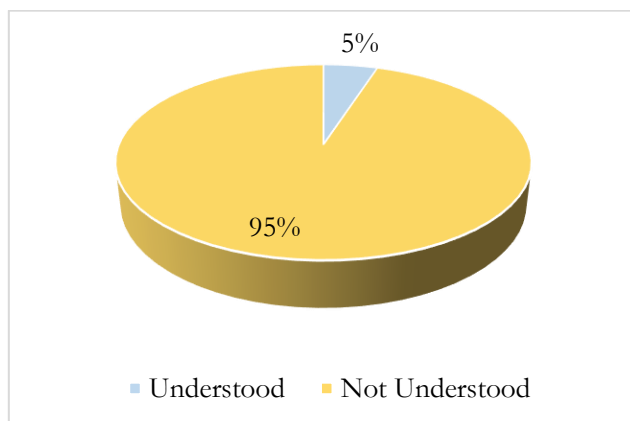


Fig. 3. Survey results on understanding related to the distillation of essential oils

2. Method

The community service in Padukuhan Tunggularum, Kalurahan Wonokerto, aimed at optimizing lemongrass cultivation into essential oil products, involved two activities. The first activity was the socialization of lemongrass essential oil distillation, and the second was a distillation training workshop. Both activities took place in Padukuhan Tunggularum and were attended by approximately 20-25 residents. The supervising lecturers for these activities were Dr. Nurul Hidayah, S.Si., and Dr. Aprilia Fitriani, S.TP., M.Sc. from the Food Technology Program, Ahmad Dahlan University, as well as Haris Imam Karim Fathurrahman, S.Pd., M.Sc., and Liya Yusrina Sabila, S.T., M.T. from the Electrical Engineering Program, Ahmad Dahlan University. Five students from the Food Technology Program (Lin

Maesyrotul Himmah, Kayladinda Zahra Kaulika, Dhamar Faturrochman, Ananda Prastika Anggara, and Arya Saksena) and one student from the Electrical Engineering Program (Ahmad Fauzi) were involved and assisted in the community service activities in Padukuhan Tunggularum.

3. Results and Discussion

The community service team, led by Dr. Nurul Hidayah, S.Si., conducted an initial meeting in Padukuhan Tunggularum. During this meeting, representatives from the Tunggularum community included Mr. Kristanto as the Head of Padukuhan and Mrs. Ningrum as the KWT (Women Farmer Group) Leader, as shown in Fig. 4. Key points from the meeting included: 1) Padukuhan Tunggularum as a partner presenting the empowerment needs of the Tunggularum community, with essential oil distillation as the primary option; 2) the service team presenting programs in both socialization and practical forms related to lemongrass distillation into essential oil; and 3) scheduling the activities in Padukuhan Tunggularum.



Fig. 4. Documentation of the service team meeting with the partner

A small-scale industrial distillation unit with a capacity of 10 kg was purchased from CV. Aneka Medica. The equipment was delivered directly to Ahmad Dahlan University Campus 4 by the supplier in good condition. The appearance of the distillation equipment is shown in Fig. 5.



Fig. 5. Assembly of essential oil distillation equipment by the supplier

Before the equipment was handed over to the partner, the lecturers and students conducted two trial runs in the Food Engineering Laboratory on the second floor of the UAD Campus 4 Laboratory Building. The trials aimed to ensure that the distillation unit functioned properly. The distillation trials used 7 kg of culinary lemongrass as the sample. Documentation of the trial is shown in Fig. 6.



Fig. 6. Documentation of distillation equipment trial (left); appearance of the distillation equipment (right)

The brief procedure for lemongrass distillation is as follows: 7 kg of lemongrass is placed in part A, part B (boiler) is filled halfway with water, part C (condenser) is filled with water and its pump. The boiler is heated using a gas stove until the temperature indicator reaches 100 °C. The distillation process lasts 5-6 hours. The distillate (distilled product) is collected using an Erlenmeyer flask, showing two layers: the upper layer is essential oil and the lower layer is water. The lemongrass essential oil is separated using a separating funnel and collected in a glass beaker (Fig. 7). For storage, the essential oil is transferred into dark glass containers [18]–[20].



Fig. 7. Results of distillation equipment trial using culinary lemongrass sample

After ensuring the equipment worked properly, it was cleaned post-trial and then handed over to Padukuhan Tunggalurum as a partner. The handover of the equipment was conducted directly by the team to the partner, represented by Mr. Kristanto as the Head of Padukuhan and Mrs. Ningrum as the KWT Leader. Documentation of the handover is shown in Fig. 8.



Fig. 8. Documentation of equipment handover from the team to the partner

On Thursday, August 29, 2024, at Mr. Kristanto's residence, the socialization of culinary lemongrass distillation using the distillation unit was held. This event was attended by the team of lecturers, students, and 25 participants from Padukuhan Tunggularum, all of whom were women (Fig. 9). During the event, Dr. Nurul Hidayah, S.Si. presented the material for approximately 1 hour, followed by a Q&A session. At the end of the socialization session, participants were required to complete a questionnaire prepared by the team of lecturers, consisting of 13 questions. There were 7 questions related to empowerment aspects and 6 questions related to knowledge aspects.



Fig. 9. Documentation of socialization activity on culinary lemongrass distillation using the distillation unit, presentation (top); group photo (bottom)

Based on the data analysis of the questionnaire results from the lemongrass distillation socialization activity, four graphs interpret the empowerment and knowledge of residents following the socialization activity. Fig. 10 shows that the majority of participants had adequate knowledge about the lemongrass distillation process into essential oil.

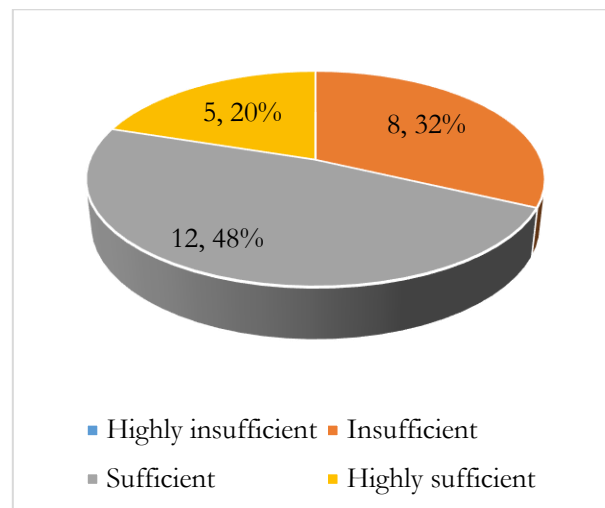


Fig. 10. Results of questionnaire data on knowledge adequacy regarding lemongrass distillation after the socialization activity

This finding is supported by the graph displayed in Fig. 13. Fig. 13 indicates how well participants answered knowledge-related questions correctly. All participants answered almost all questions correctly, with only one question about the function of the condenser in the distillation unit being answered incorrectly by most participants.

Based on the data analysis shown in Fig. 11, more than 50% of participants felt slightly capable of managing lemongrass into essential oil. This indicates that the socialization activity had a positive impact on diversifying lemongrass products, which were previously only used as culinary ingredients and herbal drinks.

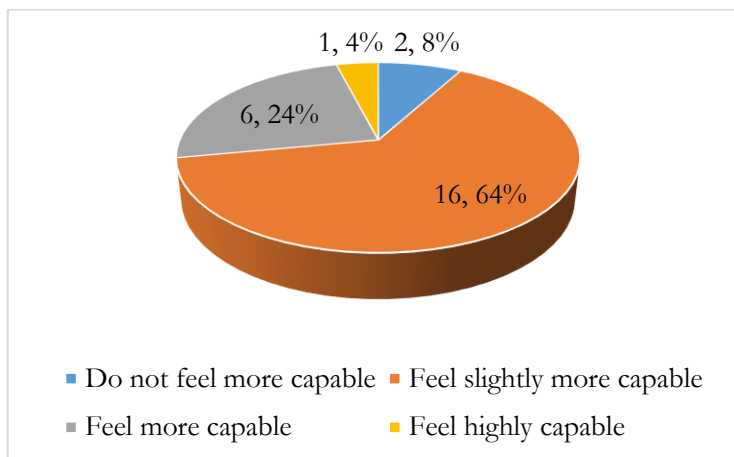


Fig. 11. Results of questionnaire data on participants' capability to manage local resources (e.g., lemongrass) after the socialization activity

Not only did it promote product diversification, but participants' mindset about the business potential of lemongrass distillation also began to develop after the socialization (Fig. 12).

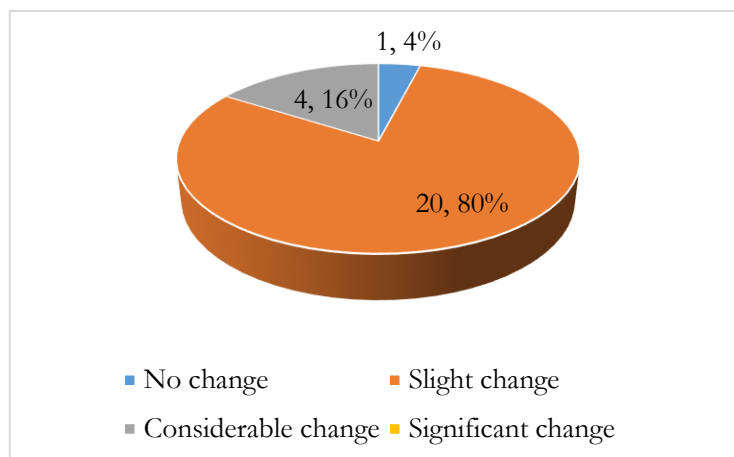


Fig. 12. Results of questionnaire data on the change in participants' mindset regarding business potential of lemongrass distillation after the socialization activity

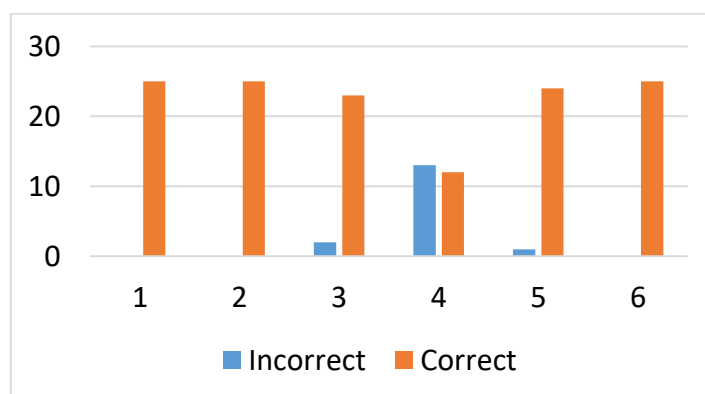


Fig. 13. Results of participants' responses to questions related to lemongrass essential oil distillation process material

Following the socialization, the distillation training for lemongrass into essential oil was conducted on September 2, 2024, in Padukuhan Tunggularum. The training was attended by 24 Tunggularum residents, all women. Participants in both the socialization and training were primarily farmers and housewives. After the lemongrass distillation practice, the team of lecturers prepared a questionnaire that participants were required to complete. Documentation of the training activity is shown in Fig. 14.



Fig. 14. Documentation of Lemongrass Distillation Training Using the Distillation Unit, Practice (top); Group Photo (bottom)

Based on the graph displayed in Fig. 15, 71% of participants had a slight level of skill in operating the distillation unit, while 29% reported having substantial skills in operating the unit. This indicates that the training provided new skills that participants might not have had before. The training reinforced residents' knowledge of lemongrass distillation, which was previously obtained only through the socialization material. During the training, participants engaged in each step of the lemongrass distillation process.

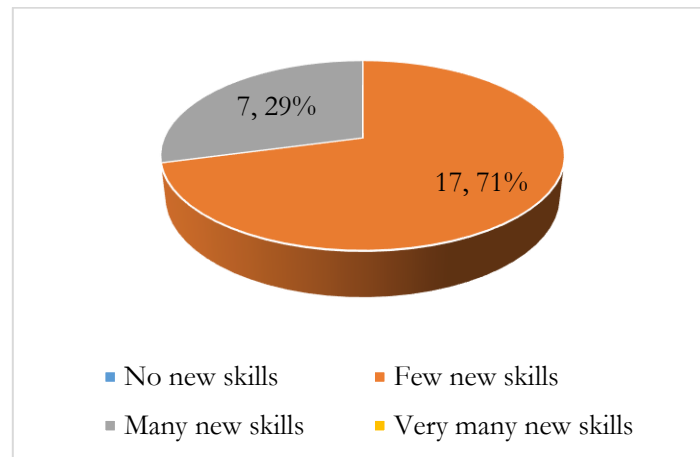


Fig. 15. Results of questionnaire data on the level of skills acquired by participants in operating the lemongrass distillation unit after the training activity

The graph in Fig. 16 shows that the majority of participants answered review questions related to lemongrass distillation correctly. Interestingly, for question 5, nearly all participants answered incorrectly. This question related to post-distillation handling of essential oil, which provides valuable feedback for the sustainability of future community service programs

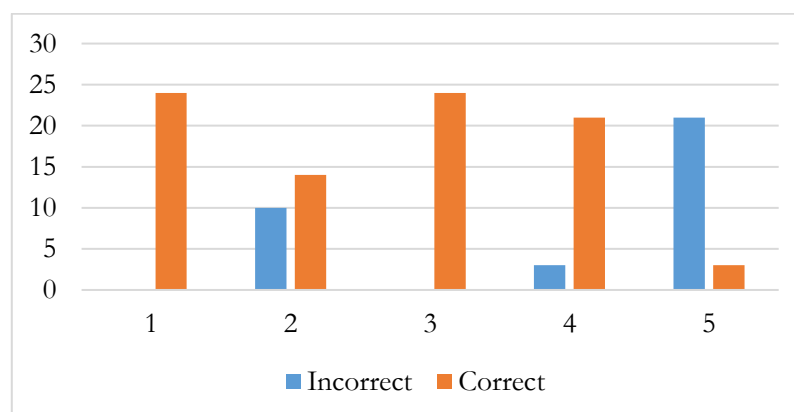


Fig. 16. Results of participants' responses to questions related to the essential oil distillation training material

4. Conclusion

The community service initiative in Padukuhan Tunggalurum, Kalurahan Wonokerto, aimed at enhancing the local cultivation of lemongrass and optimizing its conversion into essential oil, successfully achieved several key objectives. The activities, which included socialization and training on essential oil distillation, demonstrated a notable impact on the participants' knowledge and skills: 1) Knowledge Improvement: The socialization session effectively increased participants' awareness of the lemongrass essential oil distillation process. Most participants showed adequate understanding of the distillation process, although there were some gaps in knowledge about specific components, such as the function of the condenser. The training reinforced this knowledge, enabling participants to handle the distillation equipment more proficiently. 2) Skill Development: The practical training provided participants with new skills in operating the distillation unit. A significant portion of the participants reported gaining substantial new skills, which indicates the training's effectiveness in building practical competencies. 3) Empowerment and Economic Potential: The activities positively influenced participants' perceptions of their ability to manage local resources, like lemongrass, for essential oil production. There was also a marked shift in participants' mindset regarding the business potential of lemongrass distillation, suggesting increased interest in product diversification and economic opportunities.

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Declarations

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References

- [1] Badan Pusat Statistik, "Statistics of Horticultural Companies and Other Horticultural Businesses," 2023. [Online]. Available at: <https://www.bps.go.id/id/publication/2023/10/02/3a1817d874cb986a3fe79595/statistik-perusahaan-hortikultura-dan-usaha-hortikultura-lainnya-2023.html>.
- [2] A. P. Siregar *et al.*, "The Trend of Agricultural Sector Resilience in Indonesia During 2008-2020," *J. Agric. Sci. – Sri Lanka*, vol. 19, no. 2, pp. 336–357, May 2024, doi: [10.4038/jas.v19i2.10154](https://doi.org/10.4038/jas.v19i2.10154).
- [3] A. S. Tristiyanti, A. Hayani, S. D. Ardianto, and L. Kurniasari, "Effectiveness of Solid Waste Extract from Lemongrass (*Cymbopogon citratus*) as a Bioinsecticide for Controlling Whitefly (*Bemisia tabaci*) Pests on Pomelo Plants," *J. Biotechnol. Nat. Sci.*, vol. 3, no. 2, pp. 61–67, Dec. 2023, doi: [10.12928/jbns.v3i2.9669](https://doi.org/10.12928/jbns.v3i2.9669).
- [4] E. Indrawati, "Urban farming model in South Jakarta," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 106, no. 1, p. 012052, Jan. 2018, doi: [10.1088/1755-1315/106/1/012052](https://doi.org/10.1088/1755-1315/106/1/012052).
- [5] A. Kiełtyka-Dadasiewicz, J. Esteban, and A. Jabłońska-Trypuć, "Antiviral, Antibacterial, Antifungal, and Anticancer Activity of Plant Materials Derived from *Cymbopogon citratus* (DC.) Stapf Species," *Pharmaceuticals*, vol. 17, no. 6, p. 705, May 2024, doi: [10.3390/ph17060705](https://doi.org/10.3390/ph17060705).
- [6] Poerwanto, "Cultivation of Lemongrass," *Research Center for Medicinal and Aromatic Plants*. pp. 3–34, 2010, [Online]. Available at: [https://ppid.pertanian.go.id/doc/1/Budidaya/Budidaya Serai Wangi.pdf](https://ppid.pertanian.go.id/doc/1/Budidaya/Budidaya%20Serai%20Wangi.pdf).
- [7] A. Ekka, A. Tirkey, V. K. Kujur, and G. Ameen, "Review on: Genetic insights into lemongrass (*Cymbopogon flexuosus* Steud): Traditional uses to modern applications," *Int. J. Adv. Biochem. Res.*, vol. 8, no. 7, pp. 915–928, Jan. 2024, doi: [10.33545/26174693.2024.v8.i7k.1637](https://doi.org/10.33545/26174693.2024.v8.i7k.1637).
- [8] Tajidin, A. S. H., R. A. B., A. H., and M. M., "Chemical composition and citral content in lemongrass (*Cymbopogon citratus*) essential oil at three maturity stages," *African J. Biotechnol.*, vol. 11, no. 11, pp. 2685–2693, 2012, doi: [10.5897/ajb11.2939](https://doi.org/10.5897/ajb11.2939).

- [9] L. C. A. Barbosa, U. A. Pereira, A. P. Martinazzo, C. R. Á. Maltha, R. R. Teixeira, and E. D. C. Melo, "Evaluation of the chemical composition of Brazilian commercial *Cymbopogon citratus* (D.C.) stapf samples," *Molecules*, vol. 13, no. 8, pp. 1864–1874, 2008, doi: [10.3390/molecules13081864](https://doi.org/10.3390/molecules13081864).
- [10] H. A. Silva *et al.*, "Production, Market and Bioeconom of *Vetiveria zizanioides* L. (Poaceae) Essential Oil," in *Essential Oils*, Boca Raton: CRC Press, 2024, pp. 123–143, doi: [10.1201/9781032697598-10](https://doi.org/10.1201/9781032697598-10).
- [11] S. A. S. N.R. *et al.*, "Prospective Effects of Induced Mutation by Gamma Radiation in Essential Oil Production of Lemongrass (*Cymbopogon citratus*)," *Int. J. Agric. Syst.*, vol. 1, no. 1, pp. 1–21, Jun. 2013. [Online]. Available at: <http://pasca.unhas.ac.id/ojs/index.php/ijas/article/view/1>.
- [12] Juried, "Potential of Lemongrass Oil Business in Lubuk Samboa Village, Batang Natal in Increasing Community Income from an Islamic Economic Perspective," *J-MABISYA*, vol. 2, no. 1, pp. 18–27, 2021, [Online]. Available at: <https://jurnal.stain-madina.ac.id/index.php/j-mabisya/article/view/763>.
- [13] C. A. T. Machado, K. V. S. Hodel, H. A. Lepikson, and B. A. S. Machado, "Distillation of essential oils: An innovative technological approach focused on productivity, quality and sustainability," *PLoS One*, vol. 19, no. 2, p. e0299502, Feb. 2024, doi: [10.1371/journal.pone.0299502](https://doi.org/10.1371/journal.pone.0299502).
- [14] C. León, E. P. Jordán, K. Salazar, E. X. Castellanos, and F. W. Salazar, "Extraction system for the industrial use of essential oil of the subtle lemon (*Citrus aurantifolia*)," *J. Phys. Conf. Ser.*, vol. 1432, no. 1, p. 012044, Jan. 2020, doi: [10.1088/1742-6596/1432/1/012044](https://doi.org/10.1088/1742-6596/1432/1/012044).
- [15] D. P. de Sousa *et al.*, "Essential Oils: Chemistry and Pharmacological Activities," *Biomolecules*, vol. 13, no. 7, p. 1144, Jul. 2023, doi: [10.3390/biom13071144](https://doi.org/10.3390/biom13071144).
- [16] Maizer Said Nahdi And Ardyan Pramudya Kurniawan, "The diversity and ethnobotanical study of medicinal plants in the southern slope of Mount Merapi, Yogyakarta, Indonesia," *Biodiversitas J. Biol. Divers.*, vol. 20, no. 8, pp. 2279–2287, Jul. 2019, doi: [10.13057/biodiv/d200824](https://doi.org/10.13057/biodiv/d200824).
- [17] Y. Astuti, F. Hanifati, and A. Suharto, "Improving Skills and Knowledge of Healthy Drink Intake in PKK Cadres Sempu Village Wonokerto Turi Sleman," *Proceeding Int. Conf. Community Serv.*, vol. 1, no. 1, pp. 41–48, Jul. 2023, doi: [10.18196/iccs.v1i1.41](https://doi.org/10.18196/iccs.v1i1.41).
- [18] P. Masango, "Cleaner production of essential oils by steam distillation," *J. Clean. Prod.*, vol. 13, no. 8, pp. 833–839, 2005, doi: [10.1016/j.jclepro.2004.02.039](https://doi.org/10.1016/j.jclepro.2004.02.039).
- [19] Y. E. Feriyanto, P. J. Sipahutar, Mahfud, and P. Prihatini, "Extraction of Essential Oils from Lemongrass Leaves and Products Using Steam and Water Desiccation with Microwave Heating," *J. Tek. POMITS*, vol. 2, no. 1, pp. 93–97, 2013, [Online]. Available at: <https://ejurnal.its.ac.id/index.php/teknik/article/view/2347>.
- [20] U. G. A. T. Premathilake, D. L. Wathugala, and R. M. Dharmadasa, "Evaluation of chemical composition and assessment of antimicrobial activities of essential oil of lemongrass (*Cymbopogon citratus* (dc.) stapf)," *Ijmf&Ap*, vol. 4, no. 1, pp. 13–19, 2018, doi: [10.4038/jas.v13i3.8399](https://doi.org/10.4038/jas.v13i3.8399).