UTILIZATION OF HERBAL RESIDUES AND LEMONGRASS (*Cymbopogon citratus*) FOR ESSENTIAL OIL PRODUCTION THROUGH DISTILLATION TO SUPPORT COMMUNITY SELF-RELIANCE IN JUNREJO VILLAGE, BATU CITY, EAST JAVA

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Abstract

This study focuses on the utilization of herbal residues and lemongrass (*Cymbopogon citratus*), each processed separately for essential oil production using the distillation method. The activity was conducted based on the success of a medicinal plant cultivation program that aims to build a self-reliant community in producing traditional herbal medicine (*jamu*) in Junrejo Village, Batu City, East Java. The program encourages residents to optimize the use of *jamu* residues, which are often discarded, and the lemongrass plants that grow abundantly in household gardens as potential raw materials for essential oil production. The distillation process produced essential oils from both materials, which were then analyzed to determine their physicochemical characteristics. The essential oil derived from herbal residues exhibited a polydispersity index (PDI) of 1.097 ± 0.097 and a zeta potential of 65.13 ± 13.64 mV, whereas the essential oil from lemongrass showed a PDI of 2.12 ± 1.73 and a zeta potential of -94.70 ± 28.39 mV, as well as distinctive herbal and citrus aromas typical of their natural sources. This program not only provided added value to agricultural and herbal waste but also enhanced community knowledge and independence in utilizing local resources. Overall, the utilization of herbal residues and lemongrass for essential oil production demonstrates a sustainable approach to waste management and supports the empowerment of the Junrejo Village community.

Keyword: *Herbal residues, Lemongrass (Cymbopogon citratus), Essential oil, Distillation, Community empowerment*

Introduction

Indonesia is one of the richest countries in biodiversity, particularly in medicinal and aromatic plants widely used in traditional medicine systems. Essential oils extracted from these plants have significant applications in pharmaceuticals, cosmetics, food, and aromatherapy industries due to their antimicrobial, antioxidant, and therapeutic properties (Burt, 2004; Dhifi *et al*., 2016). Lemongrass (*Cymbopogon citratus*) is a widely cultivated aromatic plant known for its high citral content, which contributes to its characteristic fragrance and biological activity (Shah *et al*., 2011). In rural communities, lemongrass is often grown in household gardens but is not fully utilized for industrial or commercial purposes.

Junrejo Village, Batu City, East Java, has successfully implemented a medicinal plant cultivation program promoting traditional herbal medicine (jamu). However, jamu production generates significant herbal residues that are generally discarded. These residues still contain volatile compounds that can potentially be recovered through distillation processes (Baser & Buchbauer, 2015).

Previous studies show that plant residues from herbal processing may still contain bioactive essential oil fractions that can be recovered using appropriate extraction techniques (Stashenko & Martínez, 2008). Therefore, converting these residues into essential oils provides an opportunity for waste valorization and value-added production.

From a sustainability perspective, the utilization of agricultural waste aligns with circular economy principles, which emphasize resource efficiency and waste minimization (Chemat *et al*., 2012). Furthermore, community-based processing technologies can enhance rural self-reliance by enabling local populations to independently manage natural resources (United Nations, 2015). Based on these considerations, this study aims to utilize herbal residues and lemongrass for essential oil production using distillation technology to support community empowerment in Junrejo Village.

Materials and Method

Materials

The materials used included herbal residues from jamu production and fresh lemongrass (*Cymbopogon citratus*) collected from household gardens in Junrejo Village. A steam distillation apparatus was used for extraction. Instruments for physicochemical analysis included equipment for polydispersity index (PDI) and zeta potential measurement.

Method

Distillation Procedure

Plant materials were washed to remove impurities and chopped into smaller pieces to increase surface area and improve extraction efficiency. The prepared materials were subjected to steam distillation. Volatile compounds were released by heating, carried by steam, condensed, and separated into essential oil and aqueous phases. Steam distillation is widely recognized as one of the most efficient methods for extracting volatile compounds from aromatic plants (Khan *et al.,* 2018).

Physicochemical Analysis

The extracted essential oils were analyzed for:

- Polydispersity Index (PDI)
- Zeta potential

These parameters were used to evaluate particle distribution, dispersion stability, and colloidal behavior.

Result and Discussion

Physicochemical Characteristics

The herbal residue essential oil exhibited a PDI of 1.097 ± 0.097 and a zeta potential of 65.13 ± 13.64 mV. In contrast, lemongrass essential oil showed a PDI of 2.12 ± 1.73 and a zeta potential of −94.70 ± 28.39 mV. Zeta potential is a key indicator of colloidal stability, where values above ±30 mV indicate strong electrostatic repulsion and stable systems (Hunter, 2001). The high absolute values obtained in this study suggest that both oil systems possess good stability characteristics, although differences in sign indicate variation in surface charge properties.

Table 1. Physicochemical and Particle Characteristics of Distillates Derived from Herbal Residues and Lemongrass

Particle Characteristic in Distillate	Distillate of herbal dregs (ampas jamu)	Distillate of lemongrass (sereh)	p-value
Diameter-1 (nm)	5970.00 ± 42.43	5620 ± 339.71	0.265
Diameter-2 (nm)	455.00 ±48.00	593.50 ± 51.50	0.299
Diameter-3 (nm)	177.33 ± 27.19	136.67±16.15	0.167
Standard Deviation (nm)	2898.33 ± 71.04	2675.00 ± 317.52	0.434
Polydispersity Index (PDI)	1.097 ± 0.097	2.12 ± 1.73	0.491
Zeta Potential (mV)	65.13 ±13.64	94.70 ± 28.39	0.315
Polarity	Positive	Negative	-
Organoleptis	smells herbal	smells sweet for lemongrass	-

Variations in PDI values indicate differences in droplet size distribution and system homogeneity. Such differences are influenced by the chemical composition of each plant material and extraction behavior during distillation (Tisserand & Young, 2013). Lemongrass essential oil is rich in citral (a mixture of geranial and neral), which contributes to its strong citrus aroma and biological activity (Shah *et al.,* 2011). Herbal residues, on the other hand, contain mixed plant compounds from jamu formulations, resulting in a more complex chemical profile.

Waste Valorization and Circular Economy Approach

The findings confirm that herbal residues still contain valuable volatile compounds that can be recovered. This supports previous research indicating that plant by-products retain bioactive fractions even after primary extraction processes (Baser & Buchbauer, 2015). The transformation of waste into essential oils reflects a circular economy model where biomass is reused to maximize value before disposal. Such approaches reduce environmental burden while increasing economic potential (Chemat *et al*., 2012). Green extraction and sustainable processing of plant materials have been widely recognized as important strategies for eco-friendly production systems (Chemat *et al*., 2017).

Figure 1. Herbal Residue and Lemongrass Sample Collected for Distillation Analysis
Efficiency of Distillation Process

Efficiency of Distillation Process

Steam distillation remains one of the most widely used techniques for essential oil extraction due to its simplicity and efficiency (Khan *et al*., 2018). In this study, the method successfully extracted volatile compounds from both fresh plant material and processed residues. Although yield optimization was not measured in this study, previous research suggests that factors such as particle size, moisture content, and distillation duration significantly influence extraction efficiency (Rassem *et al*., 2016).

Community Empowerment and Knowledge Transfer

Beyond technical outcomes, the program significantly improved community knowledge and skills. Participants were trained in raw material preparation, distillation operation, and product handling. Community-based technology transfer plays an important role in rural development, as it enables individuals to independently manage and process local resources (United Nations, 2015). This empowerment increases self-reliance and encourages entrepreneurship based on locally available biomass.

Figure 2. Essential Oil Distillates Derived from Herbal Residues (left) and Lemongrass (right)

Economic and Sustainability Impact

Essential oils have high market value in cosmetic, pharmaceutical, and aromatherapy industries. Therefore, converting herbal residues and lemongrass into essential oils creates opportunities for micro-enterprise development. This approach supports sustainable development goals (SDGs), particularly responsible consumption and production patterns (United Nations, 2015; World Health Organization, 2013). It also promotes income diversification and rural economic resilience.

Conclusion

Herbal residues and lemongrass (*Cymbopogon citratus*) can be successfully utilized for essential oil production through steam distillation. The program demonstrated both technical feasibility and socio-economic benefits, including improved community knowledge, waste valorization, and potential income generation. This approach supports sustainable rural development and strengthens community self-reliance in Junrejo Village.

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References

Burt, S. (2004). Essential oils: Antibacterial properties and applications. *International Journal of Food Microbiology, 94*(3), 223–253.

Baser, K. H. C., & Buchbauer, G. (Eds.). (2015). *Handbook of essential oils: Science, technology, and applications* (2nd ed.). CRC Press.

Chemat, F., Rombaut, N., Sicaire, A.-G., Meullemiestre, A., Fabiano-Tixier, A.-S., & Abert-Vian, M. (2012). Green extraction of natural products: Concept and principles. *Green Chemistry, 14*, 930–937. https://doi.org/10.1039/C2GC16282C

Chemat, F., Vian, M. A., & Cravotto, G. (2017). Green extraction principles. *International Journal of Molecular Sciences, 18*(4), 708. https://doi.org/10.3390/ijms18040708

Dhifi, W., Bellili, S., Jazi, S., Bahloul, N., & Mnif, W. (2016). Essential oils' chemical characterization and investigation of some biological activities: A critical review. *Medicines, 3*(4), 25. https://doi.org/10.3390/medicines3040025

Hunter, R. J. (2001). *Zeta potential in colloid science: Principles and applications*. Academic Press.

Khan, M. A., Ahmad, M., Zafar, M., Sultana, S., & Jamil, A. (2018). Optimization of steam distillation process for essential oil extraction from medicinal plants. *Industrial Crops and Products, 123*, 1–8.

Rassem, H. H., Nour, A. H., & Yunus, R. M. (2016). Techniques for extraction of essential oils from plants: A review. *Australian Journal of Basic and Applied Sciences, 10*(16), 117–127.

Shah, G., Shri, R., Panchal, V., Sharma, N., Singh, B., & Mann, A. S. (2011). Scientific basis for the therapeutic use of *Cymbopogon citratus*, Stapf (lemongrass). *Journal of Advanced Pharmaceutical Technology & Research, 2*(1), 3–8. https://doi.org/10.4103/2231-4040.79796

Stashenko, E. E., & Martínez, J. R. (2008). Essential oils: Extraction, isolation and analysis. *Natural Product Communications, 3*(6), 101–114.

Tisserand, R., & Young, R. (2013). *Essential oil safety: A guide for health care professionals* (2nd ed.). Churchill Livingstone/Elsevier.

United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. https://sdgs.un.org/2030agenda

World Health Organization. (2013). *WHO traditional medicine strategy 2014–2023*. https://apps.who.int/iris/handle/10665/92455