

Cultivation and Analysis of Citronella Essential Oil Compounds for Traditional Medicine Development

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Abstract

Purpose: This study addresses challenges faced by Mahapraja, a Bali tourist cottage. It explores issues related to citronella cultivation, trust-building, limited land, equipment underutilization, and marketing hurdles. It is relevant for regional traditional medicine and agriculture.

Method: This research uses a mixed-method approach, combining qualitative data collection (interviews, surveys, observations) with quantitative analysis (Gas Chromatography-Mass Spectrophotometer). Pre- and post-tests gauge knowledge enhancement during socialization activities.

Practical Applications: The findings improve citronella cultivation in Mahapraja, boosting essential oil production and benefiting the cottage and traditional medicine industry. It informs marketing strategies, instilling confidence in producing and selling derivative products.

Conclusion: This study highlights Mahapraja's citronella challenges, setting the stage for agricultural improvements and effective marketing. It underscores research's role in advancing regional traditional medicine and agriculture, positioning Mahapraja for success in citronella essential oil production and sales.



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Introduction

Pondok Wisata Mahapraja Bangli is one of the creative tourist destinations that offer a green, rural, open-air environment, perfect for travellers looking to spend their holidays with family. Located in Puraja Hamlet, Peninjoan Village, Tembuku, Bangli–Bali, the development of this tourist attraction has been ongoing since November 2017 to the present day. The location of the tourist cottage can be seen in Figure 1. Based on information provided by our partner, the owner of Pondok Wisata Mahapraja, they are currently attempting to cultivate a new commodity, namely Citronella, precisely the Mahapengiri G1 variety, which is considered a flagship product in Peninjoan Village.

Figure 1. Location of Pondok Wisata Mahapraja



The purpose of Mahapraja in cultivating Citronella (*Cymbopogon nardus* L. Rendle) is to obtain the essential oil contained within the Citronella plant. Mahapraja possesses simple distillation equipment (Figure 2) to extract essential oil from Citronella (*Cymbopogon nardus* L. Rendle). The Citronella essential oil produced can be used in the production of various herbal oils, such as massage oil, aromatherapy, and soap. However, Mahapraja still needs to develop derivative products from Citronella essential oil (*Cymbopogon nardus* L. Rendle) for commercial purposes. Instead, they sell the essential oil to agents. This is because the derivative products produced by Mahapraja, such as massage oil, require further research and have not received approval from BPOM (the National Agency of Drug and Food Control).

There are a few challenges Mahapraja faces in developing Citronella essential oil production, such as difficulty in gaining community trust in Citronella cultivation and limited marketing of derivative massage oil products due to a lack of further research on the quality of the produced massage oil.

As an initial step in providing solutions to the challenges faced by Mahapraja in producing essential oil, this community service program will begin with Citronella Cultivation Socialization at Mahapraja Tourist Cottage in Bangli. The goal is to build trust in the community regarding Citronella cultivation. Additionally, an analysis of the Citronella essential oil produced by Mahapraja Bangli will be conducted.

Figure 2. Simple Oil Distillation Equipment



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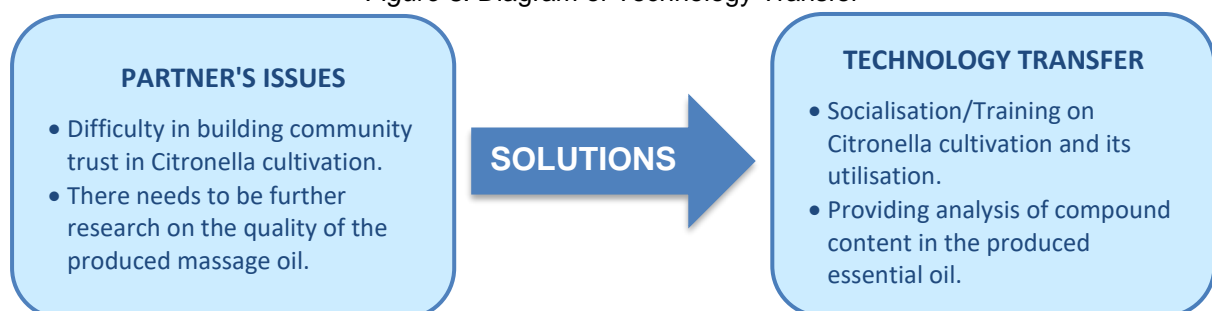
Citronella (*Cymbopogon nardus* L. Rendle) is a type of plant that contains essential oil and is considered to be well-established (Anwar et al., 2019). The utilization of Citronella plants (*Cymbopogon nardus* L. Rendle) has continued to evolve. Research conducted by (Hendrik et al. 2016) found that Citronella extract also contains terpenoids, flavonoids, and phenolics, exhibiting intense antioxidant activity with an IC50 value ranging from 50-100 ppm. Citronella plants (*Cymbopogon nardus* L. Rendle) have a relatively high content of essential oil. According to (Sulaswatty, 2019), Citronella oil composition includes 30 to 40 chemical components, including alcohols, hydrocarbons, esters, aldehydes, ketones, oxides, lactones, and terpenes. The main compounds in Citronella essential oil are oxygen-containing monoterpenes, including citronellal, geranial, geraniol, citronellol, and neral (De Toledo et al., 2016). Due to these components, Citronella essential oil is capable of inhibiting *Candida* species fungi (Toledo et al., 2016). It was also found (Lely et al., 2018) that Citronella essential oil (*Cymbopogon nardus* (L.) Rendle) has antifungal activity against *Trichophyton rubrum*, *Trichophyton mentagrophytes*, and *Candida albicans*. Moreover, Citronella essential oil formulated as a lotion to repel *Aedes aegypti* mosquitoes can provide the highest protection at a concentration of 5% Citronella essential oil (Arpiwi et al., 2020). Based on these findings, the potential use of Citronella in traditional medicine development is auspicious. Therefore, the cultivation of Citronella plants is necessary for the development of traditional medicine. The quality of Citronella leaf determines the quality of the oil produced. Cultivation techniques also influence growth and quality. The stages of Citronella cultivation include seedling preparation, soil management, planting, maintenance, rejuvenation, and pest and disease control (Suroso, 2018).

Method

This activity took place at Mahapraja Tourist Cottage*in Puraja Hamlet, Peninjoan Village, Tembuku, Bangli – Bali. The participants in this activity included nine farmers from around Mahapraja Tourist Cottage in Bangli and the management team of Mahapraja Tourist Cottage, who are involved in Citronella essential oil production. The outreach was conducted to enhance Citronella cultivation. The theme of this outreach was "Cultivation of Citronella (*Cymbopogon nardus* L. Rendle) for Traditional Medicine Development". The aim of the outreach was to motivate and inform all farmers in Puraja Hamlet about cultivating Citronella plants and the financial benefits associated with it. To enhance the participants' knowledge of Citronella cultivation, a pre-test was administered before the outreach, followed by a post-test after the outreach.

Additionally, an analysis of the compound content in the essential oil that Mahapraja has already produced was conducted to determine the quality of the essential oil. The analysis of the compound content in Citronella essential oil produced at Mahapraja Tourist Cottage was performed using a Gas Chromatography-Mass Spectrophotometer (GCMS) QP-2020 and Agilent equipment.

Figure 3. Diagram of Technology Transfer



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Result

Community Service on the Socialization of Citronella Plant (*Cymbopogon nardus* L. Rendle), Cultivation for Traditional Medicine Development at Mahapraja Tourist Cottage, Bangli, was conducted on Sunday, October 17, 2021. The event was attended by 34 participants, including local farmers, the owner of Mahapraja Tourist Cottage in Bangli, organizing committee members comprising faculty and student representatives, and speakers from "Petani Muda Keren" (Cool Young Farmers) and lecturers from Udayana University's Faculty of Agriculture. The community service activity took place at Mahapraja Tourist Cottage in Bangli, located in Puraja Hamlet, Bangli. The project leader officially opened it along with the collaborator, Mr I Ketut Nuadi Indra Sastrawan, the owner of Mahapraja Tourist Cottage in Bangli.

Efforts to increase the production of Citronella essential oil require an increase in the raw material supply. Increasing the raw material supply for Citronella production involves the participation of local farmers in the vicinity of Mahapraja Tourist Cottage in Bangli. However, one of the current challenges faced by the collaborator is the need for more community trust in Citronella cultivation. The local community still needs to be made aware of the benefits of cultivating Citronella plants. Therefore, during this community service activity, a pre-test and post-test were conducted before and after the event to assess the participant's knowledge regarding the benefits of Citronella cultivation. In this case, the participants were local farmers in the vicinity of Mahapraja Tourist Cottage in Bangli.

The participants in this activity included male farmers of various ages and educational backgrounds. The participants' education levels were predominantly graduates of Junior High School, with the highest level of education being Diploma 1, and some participants had no formal education. The age range of participants in this socialization ranged from 25 to 61 years old. Before the socialization activity on Citronella plant cultivation for traditional medicine began, participants were provided with brochures and questionnaires related to the community's knowledge of Citronella plant cultivation and utilization as a health product. This served as a pre-test covering participants' personal information, knowledge about the benefits of Citronella plants, and knowledge about how to cultivate Citronella plants.

To address the challenge of building community trust in Citronella plant cultivation around Mahapraja Tourist Cottage, the community service activity at Mahapraja Tourist Cottage invited two expert speakers in the field. Dr. Ir. Ni Luh Kartini, M.S., delivered a presentation on Citronella Plant Cultivation and Its Financial Benefits, while Mr. I Nengah Sumerta covered Citronella Plant Cultivation Techniques. The delivery of these presentations during the socialization activity is illustrated in Figure 4.

Figure 4. Presentation by Dr. Ir. Ni Luh Kartini, M.S.



During the material presentation session, it was evident that the participants in the socialization activity, represented by farmers from the Mahapraja Tourist Cottage area, were very enthusiastic. This was demonstrated by the engaging discussion and interaction that took

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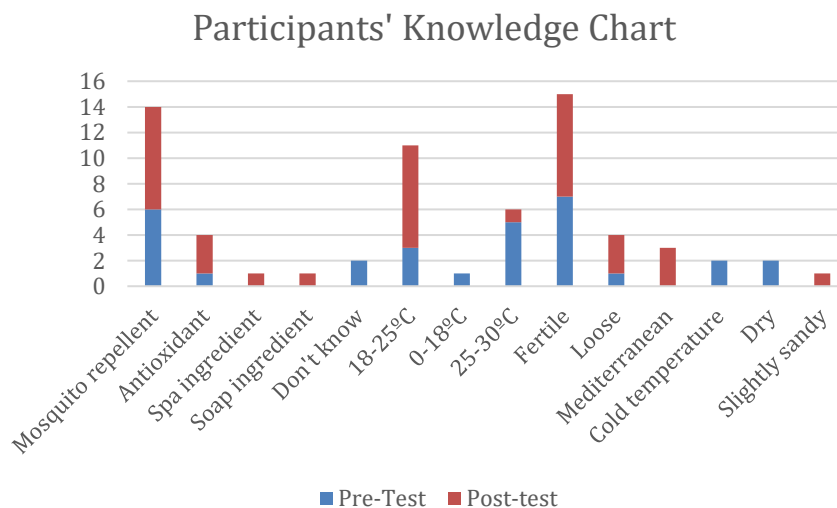
place during the socialization activity. Most of the participants had questions related to how to cultivate and utilize Citronella plants and other plants that may have significant potential for cultivation. Image 5 shows one of the farmers asking questions to the two speakers during the event.

Figure 5. Socialisation participants ask questions to the speakers.



After the presentation of materials by the speakers and the discussion with the participants of the socialization activity, the next activity was to administer the second questionnaire in the form of a post-test. The questionnaire distributed to the participants consisted of questions about the participant's level of knowledge regarding the utilization and cultivation of Citronella plants.

Figure 6. Participants' knowledge before and after the socialization



Based on the questionnaire results obtained, participants' knowledge regarding the benefits of citronella plants increased, as shown in Figure 6. The pre-test results indicated that there were participants in the socialization who were not aware of the benefits of citronella plants. However, after distributing brochures, presenting materials by the speakers, and engaging in discussions, the post-test results showed an improvement with a decrease in the number of participants who answered that they did not know the benefits of citronella plants. According to the questionnaire results, citronella plants can be used as mosquito repellent, antioxidants, additives in soap, and as ingredients in spa products.

The questionnaire given to the participants also revealed their level of knowledge about the cultivation techniques of citronella plants, including knowing the suitable temperature for growing citronella plants and the appropriate soil type. Figure 6 shows the participants'

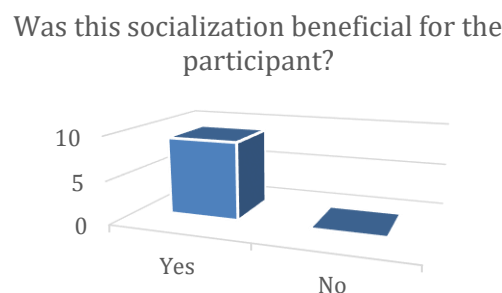
knowledge graph regarding the suitable temperature for growing citronella plants. In the pre-test results in Figure 6, it can be seen that participants needed to be made aware of the suitable temperature for growing citronella plants. Only 3 out of 9 participants present provided the correct answer, which is 18-25°C. After the participants read the brochures provided by the organizers of the socialization and listened to the presentation by the two speakers, there was an improvement in the post-test results during this socialization activity, with all participants answering correctly with a temperature range of 18-25°C.

Furthermore, Figure 6 also shows the graph of knowledge about the suitable soil type for planting citronella plants. In the graph, it can be seen that participants answered that the suitable soil type for planting citronella plants is fertile, loose, cold, and dry soil. According to (Suroso, 2018), citronella plants are suitable for planting in fertile, loose soil with a high organic content. They can be grown in various soil contours, and Mediterranean yellow-brown or sandy-brown soil is also suitable for planting citronella plants. The soil should have a pH range of 6-7.5. After reading the brochure and participating in the socialization, the participants' knowledge increased, and they answered that the suitable soil was fertile, loose, Mediterranean, and slightly sandy.

On the post-test sheet, there are questions related to feedback from the participants regarding the conducted activities. There are three questions given, as follows:

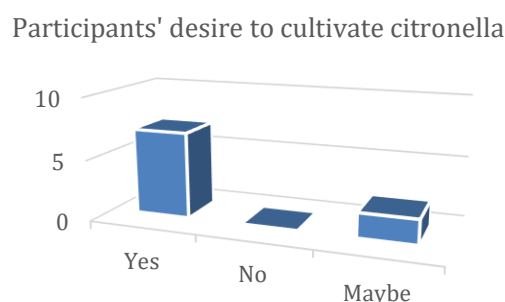
1. Was this socialization beneficial for you (the participant)?
2. After this socialization, do you (the participant) want to cultivate citronella plants?
3. Provide feedback, suggestions, and input regarding this socialization!

Figure 7. Graph of the benefits of socialization for the participants



The answer to the first question can be seen in Figure 7, which is the graph of the benefits of socialization for the participants. Figure 7 shows that all participants answered "Yes," meaning that the socialization was beneficial for the participants in cultivating citronella plants at Pondok Wisata Mahapraja Bangli.

Figure 8. Graph of the participants' desire to cultivate citronella plants



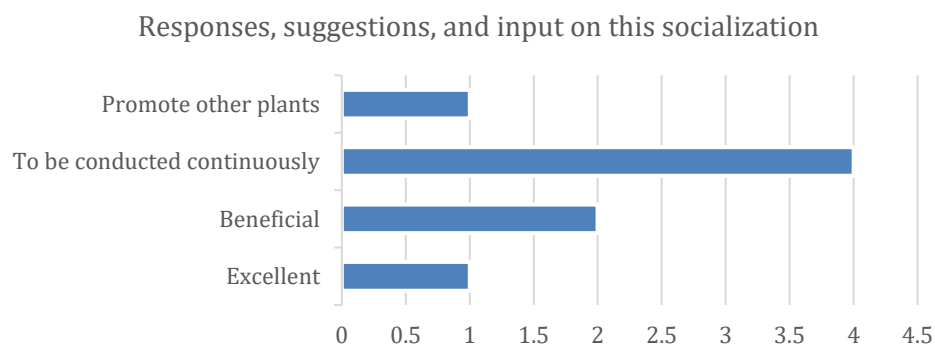
The response to the second question, which is about the participants' desire to cultivate citronella plants, is shown in Figure 8. Figure 8 indicates that after the citronella plant cultivation socialization activity, the participants are willing to cultivate citronella plants. However, there are still some individuals who need more support in their willingness to

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cultivate citronella plants. This is evident in the graph of the participants' desire to cultivate citronella plants, with some answering "maybe".

Looking at Figure 9, the feedback regarding the citronella plant cultivation socialization activity received a positive response. There is positive feedback, suggestions, or input for the community service that has been conducted. Figure 9 shows that the participants in the socialization activity feel that the conducted activity has been beneficial for them. In this case, the participants who attended were farmers in the Pondok Wisata Mahapraja Bangli area. They mentioned that the activity was perfect and should be conducted regularly. They also suggested promoting other plant types with significant potential and opportunities in terms of health and the economy.

Figure 9. Graph of feedback on this socialization



Pondok Wisata Mahapraja has a simple steam distillation apparatus used to produce essential oil. Currently, Mahapraja Pondok Wisata produces essential oil from lemongrass plants of the Mahapengiri G1 variety. In this community service activity, the organizing committee provides services to analyze the compound content present in the lemongrass essential oil that has been produced, with the aim of marketing the produced essential oil to contribute to the economic improvement of the community around Pondok Wisata Mahapraja.

The organizing committee has analysed lemongrass essential oil using GCMS Agilent 5977B with a programmed temperature range from 70°C (4 minutes) to 290°C (5 minutes) at a rate of 10°C per minute for a total analysis time of 31 minutes. Based on the analysis results of the lemongrass essential oil of the Mahapengiri G1 variety produced by Pondok Wisata Mahapraja Bangli, four major compounds were found in the essential oil at retention times of 9.505, 10.706, 11.134, and 12.982 minutes. The analysis results in Table 4.1 indicate that the lemongrass essential oil produced by Pondok Wisata Mahapraja Bangli contains the following compounds: Citronellal (49.22%), Citronellol (14.99%), Geraniol (26.69%), and Geranyl Ethyl Carbonate (9.10%).

Table 3. Compound Content in Lemongrass Essential Oil Produced by Pondok Wisata Mahapraja Bangli

Peak	Retention Time (min)	%Area	Compound
1	9,505	49,22	Citronellal
2	10,706	14,99	Citronellol
3	11.134	26,69	Geraniol
4	12.982	9,10	Geranyl Etil Carbonat

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Discussion

Community service with the theme "Cultivation of Lemongrass (*Cymbopogon nardus* L.) for Traditional Medicine Development" was conducted by inviting two speakers during the socialization session led by Dr Ir. Ni Luh Kartini, M.S., which focused on lemongrass cultivation and its financial benefits, showcased a lemongrass-scented hand sanitizer product, as seen in Figure 10, to demonstrate the use of lemongrass. According to (Andila, 2020), hand sanitizers with compositions including lemongrass oil, aloe vera, and active betel leaves can be used as antiseptics while considering potential allergic reactions. Hand sanitizers have market demand and personal benefits (Fitri et al., 2020). The farmers responded with appreciation and expressed their interest in learning more about the utilization of lemongrass.

(Mursalin et al., 2020) Mentioned that lemongrass oil is valued at Rp 250,000 per liter, and the residual waste from distillation can be used as animal feed (Rp 150/kg) or turned into rich compost (Rp 1,200/kg). The value-added ratio of lemongrass oil products is 84%, meaning that 84% of the output value (lemongrass oil products) is obtained from the lemongrass processing into lemongrass oil (Ernita et al., 2019).

Figure 10. Presentation of Lemongrass-Scented Hand Sanitizer by the Speaker



The second speaker, Mr. I Nengah Sumerta, presented the socialization of lemongrass cultivation techniques. The speaker explained the stages of lemongrass cultivation and also discussed how to grow lemongrass to obtain a high level of lemongrass essential oil. The community service conducted for farmers around Pondok Wisata Mahapraja Bangli generated enthusiastic participation. After the socialization, the farmers were able to answer the post-test questions effectively. As seen from the knowledge gained about the benefits of lemongrass, the farmers now understand the advantages offered by lemongrass, such as its use as a mosquito repellent, antioxidant, soap additive, hand sanitizer, and as an ingredient in spa products (Gafur & Sriwahyuni, 2022). This aligns with the findings of (Hendrik et al. 2016), who discovered that lemongrass extract exhibits vigorous antioxidant activity with an IC50 value ranging from 50-100 ppm. Additionally, lemongrass essential oil formulated as a mosquito repellent lotion was found to provide the highest protection at a 5% concentration (Arpiwi et al., 2020).

The participant's knowledge regarding lemongrass cultivation techniques, including suitable temperature and soil types, improved significantly after reading the brochures and attending the socialization. In the post-test, all participants correctly answered that the suitable temperature for growing lemongrass is between 18-25°C, which is consistent with the (Suroso, 2018) recommendation for lemongrass cultivation conditions. Furthermore, their knowledge of the appropriate soil type for lemongrass cultivation improved, with participants now recognizing that lemongrass grows well in fertile, loose, Mediterranean, and slightly sandy soil.

In general, the participants' knowledge regarding lemongrass cultivation for traditional medicine development increased, and they expressed hope that similar activities could be conducted with different plant varieties.

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Regarding the analysis of lemongrass essential oil, specifically Mahapengiri G1 produced by Pondok Wisata Mahapraja Bangli, four significant compounds were identified: Citronellal (49.22%), Citronellol (14.99%), Geraniol (26.69%), and Geranyl Ethyl Carbonate (9.10%). According to (Bota et al., 2015), these compounds are the main constituents of lemongrass oil and can be used for their antibacterial properties. (Syakir et al., 2020) found that the citronella content reached 41.59% with the application of nitrogen at 6.9 g/plant during cultivation. (Gusmaini et al., 2021) It was stated that potassium application in Andosol soil is essential for primary metabolite processes in moderate amounts but does not directly affect secondary metabolite production (oil content and citronella levels).

Following this community service, the participating farmers immediately began lemongrass cultivation to increase essential oil production at Pondok Wisata Mahapraja. With the availability of essential oil content analysis services, Pondok Wisata Mahapraja Bangli gained more confidence in creating derivative products from the essential oil, which could be used as merchandise at Pondok Wisata Mahapraja Bangli. Therefore, Pondok Wisata Mahapraja Bangli hopes to continue these activities by producing financially beneficial products.

Conclusion

Based on the results of the pre-test and post-test, there was an improvement in knowledge, as the two individuals who initially did not know the benefits of cultivating lemongrass now have full awareness of its advantages. Knowledge about how to cultivate lemongrass also increased from 44.44% to 100%, with all participants in the socialization program now being knowledgeable about lemongrass cultivation. Additionally, this community service program provided services for Mahapraja to analyze the compound content in the essential oil they produced. The results indicated that the lemongrass essential oil produced by Pondok Wisata Mahapraja Bangli contained the following compounds: Citronellal (49.22%), Citronellol (14.99%), Geraniol (26.69%), and Geranyl Ethyl Carbonate (9.10%). The sustainability of this initiative aims to increase the quantity of essential oil produced by Pondok Wisata Mahapraja and develop derivative products from lemongrass essential oil.

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Reference

- Andila, P. S. (2020). Formulasi Handsanitizer Dengan Bahan Aktif Sirih (Piper Betle L.), Lidah Buaya (Aloe Vera (L.) Burm. F.) Dan Minyak Atsiri Sereh Wangi (Cymbopogon Winterianus Jowitt) Untuk Mencegah Covid-19. *Buletin Udayana Mengabdikan*, 19(3), 375–381.
- Anwar, Y., Kumala, S., Iftitah, E. D., & Simanjuntak, P. (2019). Isolasi dan Identifikasi Senyawa Geraniol dari Minyak Atsiri Tanaman Sereh Wangi Cymbopogon nardus (L.) Rendle. *Jurnal Ilmu Kefarmasian Indonesia*, 17(2), 183. <https://doi.org/10.35814/jifi.v17i2.746>
- Arpiwi, N. L., MUksin, I. K., & Kartini, N. L. (2020). Essential oil from Cymbopogon nardus and repellent activity against Aedes aegypti. *Biodiversitas Journal of Biological Diversity*, 21(8), Article 8. <https://doi.org/10.13057/biodiv/d210857>
- Bota, W., Martosupono, M., & Rondonuwu, F. S. (2015). Potensi Senyawa Minyak Sereh Wangi (Citronella Oil) Dari Tumbuhan Cymbopogon Nardus L. Sebagai Agen Antibakteri. *Prosiding Semnastek*, 0, Article 0. <https://jurnal.umj.ac.id/index.php/semnastek/article/view/548>
- De Toledo, L. G., Ramos, M. A. D. S., Spósito, L., Castilho, E. M., Pavan, F. R., Lopes, É. D. O., Zocolo, G. J., Silva, F. A. N., Soares, T. H., Dos Santos, A. G., Bauab, T. M., & De

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- Almeida, M. T. G. (2016). Essential Oil of *Cymbopogon nardus* (L.) Rendle: A Strategy to Combat Fungal Infections Caused by *Candida* Species. *International Journal of Molecular Sciences*, 17(8), 1252. <https://doi.org/10.3390/ijms17081252>
- Ernita, Y., Novita, S. A., Jamaluddin, J., Laksmana, I., & Rildiwan, R. (2019). Analisis Nilai Tambah Dan Kelayakan Finansial Industri Minyak Serai Wangi. *Journal of Applied Agricultural Science and Technology*, 3(1), 91–104.
- Fitri, N., Purwaningsih, T., Falahziez Anfasa Firdaus, A., Purnika, D., Luthfi Kustiawan, R., Ardisetya, S., & Shanty Retno Triwening, N. (2020). *Hand Sanitizer Berbasis Minyak Atsiri Untuk Mengembangkan Desa Loano, Kecamatan Loano, Kabupaten Purworejo, Jawa Tengah Sebagai Sentra Produk Berbasis Minyak Atsiri*. <https://dspace.uui.ac.id/handle/123456789/25863>
- Gafur, A., & Sriwahyuni, E. (2022). Pelatihan Penyulingan Serai Wangi dan Pembuatan Produk Turunan Menjadi Handsanitizer dan Sabun Cuci Tangan Kelompok Tani Desa Teluk Pambang, Bengkalis. *Jurnal Abdi Masyarakat Indonesia*, 2(1), Article 1. <https://doi.org/10.54082/jamsi.142>
- Gusmaini, G., (Eco-physiology), (ID Scopus : 55993024200), Syakir, M., & Perkebunan, P. R. pada P. P. dan P. (2021). *Effect Of Potassium on Growth, Yield and Quality Of Citronella Grass*. <https://repository.pertanian.go.id/handle/123456789/13495>
- Hendrik, H., Erwin -, & Panggabean, A. S. (2016). Pemanfaatan Tumbuhan Serai Wangi (*Cymbopogon Nardus* (L.) Rendle) Sebagai Antioksidan Alami. *Jurnal Kimia Mulawarman*, 10(2). <http://jurnal.kimia.fmipa.unmul.ac.id/index.php/JKM/article/view/34>
- Lely, N., Sulastri, H., & Meisyayati, S. (2018). Activity Antifungi of Oil Atsiri Sereh Wangi (*Cymbopogon Nardus* (L.) Rendle). *Jurnal Kesehatan Saemakers Perdana (JKSP)*, 1(1), Article 1. <https://doi.org/10.32524/jksp.v1i1.100>
- Mursalini et al. (2020). *Pengembangan Tanaman Sereh Wangi untuk Bioreklamasi Lahan dan Pemberdayaan Ekonomi Masyarakat di Muaro Jambi | Agrokreatif: Jurnal Ilmiah Pengabdian kepada Masyarakat*. <https://journal.ipb.ac.id/index.php/j-agrokreatif/article/view/27823>
- Sulaswatty, A. (2019). Quo Vadis Minyak Serai Wangi dan Produk Turunannya. Dalam *Penerbit BRIN*. Penerbit BRIN. <https://penerbit.brin.go.id/press>
- Suroso. (2018). *Prospek Serai Wangi - Budidaya Serai Wangi (Cymbopogon Nardus L. Randle) Disusun Oleh: Suroso - Studocu*. <https://www.studocu.com/id/document/universitas-sumatera-utara/agribisnis/prospek-serai-wangi/47699306>
- Syakir, S., Perkebunan, P. P. dan P. T., Gusmaini, G., & Obat, B. P. T. R. dan. (2020). *Increasing Lemongrass Herb Yield and Quality Through Nitrogen Addition*. <https://repository.pertanian.go.id/handle/123456789/10776>