Identifying Endorphin-Stimulating Compounds In Cananga Var. Macrophylla Essential Oil

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Abstract

This research investigates Cananga var. macrophylla essential oil with the aim of identifying potential endorphin- stimulating compounds. The essential oil was subjected to a comprehensive analysis involving various analytical techniques. The physical and chemical properties of the oil were assessed, including specific gravity and refractive index measurements, to ensure compliance with established quality standards. This study conducted a comprehensive analysis of Cananga var. macrophylla essential oil to assess its quality and investigate its potential as a natural stimulant for endorphin release. The essential oil was subjected to rigorous physical and chemical characterization, including specific gravity and refractive index measurements, which confirmed its adherence to established quality standards, rendering it suitable for diverse applications. Nonetheless, the primary objective was to identify specific compounds within the essential oil with the capacity to stimulate endorphin production. Gas Chromatography-Mass Spectrometry (GC-MS) was employed for compound identification, revealing several significant compounds with substantial percentages. Notably, benzene, 1-methoxy-2-methyl-, caryophyllene, ç- muurolene, and linalool emerged as the predominant constituents, all recognized for their potential in eliciting endorphin release. This physiological response is associated with mood enhancement and overall well-being, making these compounds of considerable interest. The findings suggest that Cananga var. macrophylla essential oil possesses promising attributes as a natural substance capable of promoting endorphin production. Its potential as an agent for aromatherapy and mood-enhancing therapies merits exploration. However, further research is imperative to elucidate the precise mechanisms and therapeutic benefits of endorphin stimulation induced by this essential oil. This investigation represents a significant step toward a more profound comprehension of the psychological and physiological effects associated with Cananga var. macrophylla essential oil. It serves as a catalyst for future studies aimed at harnessing the innate properties of essential oils for therapeutic applications, potentially contributing to enhanced emotional well-being and overall health.

Introduction

Indonesia, renowned for its diverse and valuable medicinal plants, has a long-standing tradition of utilizing traditional medicine as an alternative healthcare approach(AMMAR et al., 2021; Nugraha & Keller, n.d.). This practice of traditional medicine has been deeply rooted in Indonesia's culture and history, playing a significant role in addressing various health issues among its population (Pengpid & Peltzer, 2018). Traditional medicine in Indonesia is known for its accessibility and affordability, making it a preferred choice for many individuals seeking disease treatment and improved well-being. Traditional medicine, which includes the use of herbal remedies, has gained significant popularity and trust among the Indonesian population (Pols, 2009). It is often sought after as an effective and more cost-effective alternative to modern pharmaceutical drugs. This preference for traditional medicine aligns with the Indonesian government's recommendations for sustainable resource management and empowerment, particularly in the field of healthcare(Harimurti et al., 2017; Tan et al., 2015a).

One of the natural ingredients found in herbal medicine, highly valued for its therapeutic properties, is Ylang-Ylang (Cananga odorata) (Indrasetiawan et al., 2019; Suryani et al., 2022; Tan et al., 2015b). Ylang-Ylang, also known as C. odorata forma macrophylla, is an aromatic flowering tree native to tropical regions, including Indonesia(Nurhayani et al., 2019; Sharmeen et al., 2021) Its fragrant and captivating flowers have made it an essential plant source for traditional medicine practitioners and herbalists.

Ylang-Ylang essential oil, extracted through various methods like steam distillation, is highly regarded for its versatile applications in aromatherapy, skincare, and overall well-being(Bunse et al., 2022; Curtis et al., 2016). The aromatic allure of Ylang-Ylang, combined with its potential therapeutic benefits, has made it an integral part of deeply rooted traditional healing practices in Indonesian culture (Halder et al., 2018; Propantoko et al., 2020). Many communities use Ylang-Ylang flowers in ritualistic cultivation and extract its essential oil for various purposes (Donald, 2015). Additionally, its flowers can be utilized to ward off malaria mosquito bites, and its leaves can be rubbed on the skin to alleviate itching. The oil derived from Ylang-Ylang is known to have calming effects on the nervous system, helping to relieve anxiety, tension, and fear, serving as an antidepressant and tranquilizer for humans(Meisya Putri et al., 2020; Toghueo et al., 2017). The increasing prevalence of mental health disorders has created a trend that necessitates a better understanding of the use of natural resources, such as essential oils, in more sustainable and safe mental healthcare. In this context, this research aims to identify potential endorphin-stimulating compounds in Cananga var macrophylla essential oil, with the hope that this discovery may offer a potential solution for improving mental well-being, reducing stress, and contributing to the development of safer and sustainable alternative healthcare.

MATERIALS AND METHODS

The research was conducted from May 5th to November 2023 at two laboratory locations: the Atsiri Research Center (ARC) at Syiah Kuala University and the Multifunctional Laboratory at UIN Ar-Raniry in Banda Aceh. This study focused on the Ylang-Ylang flower, utilizing a range of sophisticated equipment, including dropper pipets, test tubes, analytical balances, and a GC-MS spectrophotometer, among other laboratory tools. The materials for the study comprised fresh Ylang-Ylang flowers, distilled water, and various chemicals such as chloroform, methanol, and concentrated acids, which were critical for the extraction and analysis processes. The sampling of Ylang-Ylang flowers (Cananga odorata) was conducted randomly in the KAB Pidie Jaya region, ensuring that the samples were in a youthful state, displaying vibrant green hues transitioning to subtle yellow tones. This careful selection aimed to guarantee the freshness and quality of the flowers for subsequent analyses. Taxonomic assessments were meticulously carried out at the Biology Laboratory of UIN Ar-Raniry, where the plant material was accurately identified and categorized, laying the groundwork for further phytochemical exploration.

Phytochemical testing involved extracting compounds from the fresh Ylang-Ylang flowers using 96% ethanol and analyzing the essential oil obtained through steam and water distillation. Various tests were performed to detect specific phytochemicals, such as flavonoids, steroids, saponins, triterpenoids, and tannins. Each test was systematically conducted, using precise measurements and careful observations to identify any chemical reactions indicative of the presence of these compounds.

The extraction of Ylang-Ylang essential oil was performed by cutting the flower samples into 1 cm pieces and distilling them for eight hours at the boiling point of water. The oil was collected through a condenser and separated from water using a separating funnel. The addition of anhydrous sodium sulfate facilitated the removal of water molecules from the oil, ensuring a purer product for analysis. The extracted oil underwent rigorous physical and chemical characteristic testing, including assessments of refractive index, specific gravity, ester value, acid value, and solubility in ethanol, with the goal of ensuring compliance with the SNI 06-3949-1995 standards for Ylang-Ylang essential oil quality. The evaluation of physical and chemical properties was conducted at the Chemistry Laboratory of UIN Ar-Raniry, where each property was measured using standardized procedures. For instance, the refractive index was determined using an Abbe refractometer, while specific gravity was assessed using a pycnometer. The ester and acid values were calculated through titration methods, providing insights into the oil's chemical composition. The identification of chemical compounds within the Ylang-Ylang essential oil was performed using Gas Chromatography-Mass Spectrometry (GC-MS). This meticulous analysis employed an Elite-5MS capillary column, with helium gas as the mobile phase. The temperature of the column was carefully programmed to allow for optimal separation and identification of compounds. The results indicated the presence of various constituents, including linalool, highlighting the

chemical complexity of Ylang-Ylang essential oil and its potential applications in various industries, such as perfumery and aromatherapy. This comprehensive study not only contributes to the understanding of Ylang-Ylang's phytochemical profile but also lays the groundwork for future research and application in natural product chemistry.

Data Analysis

Ylang-Ylang Essential Oil Yield Table 1 Results of Ylang-Ylang Essential Oil Extraction Yield

Table 1 Results of Ylang-Ylang Essential Oil Extract Yield"

Fresh Sample Weight (grams)	Extracted Oil Weight (grams)	%% Yield
6.203,7 g	47,7671 g	0,7699 %

Table 2 Results of Specific Gravity Values"

No	Sample	(m1) gram	(m2) gram	(m3) gram	Average (grams) |	Specific Gravity
1	Pycnometer	30,5792	30,5796	30,5797	30,5795	-
2	Pycnometer + water	80,1251	80,1250	80,1249	80,1250	1
3	Pycnometer + ylang-ylang essential oil	75,6873	75,6872	75,6883	75,6876	0,9104

ester number (be)

- Weight of ylang-ylang oil: 2.0048 grams
- Volume of HCl for the sample (V1): 3.4 mL
- Volume of HCl for the blank (V2): 6.4 mL
- Normality of HCl: 0.25 N
- Molecular weight of KOH: 56.1 g/ml

The formula for ester number (BE) is as follows: BE = (V2 - V1) x N x 56.1 / Mass of the sample Using the provided values:

BE = (6.4 mL - 3.4 mL) x 0.25 N x 56.1 / 2.0048 grams

BE = 20.9871

Therefore, the ester number is approximately 20.9871.

Acid Number (BA

- Weight of ylang-ylang oil: 2.0056 grams
- Volume of KOH: 0.3 mL
- Normality of KOH: 0.2 N
- Molecular weight of KOH: 56.1 g/ml

The formula for Acid Number (BA is as follows: BA = V x N x 56.1 / Mass of the sample

Using the provided values:

BA = (0.3 mL) x (0.2 N) x (56.1 g/ml) / 2.0056 grams

BA = 1.678

Thus, the Acid Number (BA) is approximately 1.678.

RESULTS AND DISCUSSION

Taxonomic Examination

In this research, a thorough taxonomic examination of the plant species was conducted at the Biology Laboratory of the Faculty of Science and Technology, Ar-Raniry State Islamic University in Banda Aceh. The outcomes of this taxonomic analysis are presented comprehensively in Table 3 below:

Table 3: Results of Taxonomic Examination

Kingdom	: Plantae
Superdivisi	: Spermatophyta
Divisi	: Magnoliophyta
Kelas	: Magnoliopsida
Ordo	: Magnoliales
Fmilia	: Annonaceae
Genus	: Cananga
Spesies	: Cananga odorata (Lamk.) Hook
Varietas (Forma)	: Cananga odorata. (Lamk.) Hook.f. & Thomso forma macrophylla

This taxonomic investigation serves as a crucial foundation for precisely classifying and identifying the plant species under study, Cananga odorata (Lamk.) Hook.f. & Thomso forma macrophylla. By categorizing the plant within its taxonomic hierarchy, researchers gain valuable insights into its botanical classification and relationship with other organisms in the plant kingdom, contributing to a deeper understanding of its characteristics and potential applications.

Phytochemical Screening

Phytochemical screening was conducted on fresh Ylang-Ylang flower extracts using 96% ethanol as the solvent and on Ylang-Ylang essential oil obtained through steam and water distillation, following the methodology referenced from a research journal [20]. The choice of ethanol as the solvent for the fresh flower extracts is highly suitable due to its ability to effectively bind the desired secondary metabolite compounds during the phytochemical screening process. The outcomes of the phytochemical screening are presented comprehensively in the following table:

Table 4. Phytochemical Screening

No.	Test Type	Fresh Ylang-Ylang Flowers	Ylang-Ylang Essential Oil
1.	Flavonoid	Presence of brick-red color (+) positive	Presence of orange-brown color (+) positive
2.	Tannin	Presence of green layer (+) positive	Absence of green layer (-) negative
3.	Triterpenoid	Change in color to red (+) positive	Change in color to red (+) positive
4.	Saponin	No formation of foam (-) negative	Formation of foam (+) positive
5.	Steroid	Change in color to dark brown (+) positive	Change in color to reddish-brown (+) positive

Based on the data presented in the table above, it is evident that a majority of the compounds in the samples were positively identified. The examination for flavonoids yielded positive results for both the ethanol extract of fresh ylang-ylang flowers and the ylang-ylang essential oil samples. The presence of flavonoid compounds was indicated by the development of a deep red color in the test solution (Meisya Putri et al., 2020). In contrast, (Mondong et al., 2015) have noted that a positive flavonoid test manifests as a color transition from red to orange. Therefore, the presence of flavonoids in both sample types was confirmed. The assessment of the secondary metabolite tannin was only positive in the ethanol extract of fresh ylang-ylang flowers, characterized by the formation of a green layer in the solution. However, this reaction was not observed in the ylang-ylang essential oil sample. A positive outcome in the tannin test is typically indicated by the appearance of a dark green to black or blue layer in the solution(Mondong et al., 2015). The absence of the expected color change in the essential oil sample may be attributed to differences in solvent types and the distillation process, which may not have fully extracted or isolated the tannin compound. The triterpenoid test produced positive results in both sample types, as indicated by a color shift from red to brownish in the test solution. Munadi, (2020) has asserted that a positive test for terpenoids is characterized by a color shift to reddish-brown in the sample solution, arising from oxidation reactions within the terpenoid compound group and the formation of conjugated double bonds.

The saponin test returned positive results exclusively in the ylang-ylang essential oil sample, while it yielded negative results in the ethanol extract of fresh ylang-ylang flowers. A positive indication of saponins is the formation of stable foam in the sample solution after continuous agitation for 5 minutes. Foam development in this test is attributed to the hydrolysis of glycoside compounds, leading to the production of glucose and other compounds within the aqueous medium(Eka Puspa et al., 2017). The steroid test yielded positive results in both test samples, marked by a color transformation to brown, consistent with the findings of where the presence of steroids was corroborated by the emergence of a brown hue in the ylang-ylang essential oil sample.

3.3 Essential Oil Distillation

The extraction of ylang-ylang flower essential oil involved the processing of approximately 6,203.7 grams of fresh flowers. These flowers were selected using purposive sampling, a technique that randomly selects samples from specific regions. In this case, the sampling area was limited to Jangka Buya, Aceh Jaya. Furthermore, the selection criteria focused on ylang-ylang trees with large blossoms, specifically the Cananga odorata (Lamk.) Hook.f. & Thomso forma macrophylla variet. Following the collection of the samples, a sample preparation stage preceded the distillation process. The ylang-ylang flowers were finely chopped into pieces measuring approximately 0.5- 1 cm. This chopping process aimed to increase the surface area of the flower samples, allowing for better exposure of chemical compounds during the subsequent heating phase in the distillation process. The prepared samples were then placed into the sample flask of the steam and water distillation apparatus, and the distillation process commenced, lasting for 8 hours.

The distillation process began with water boiling, producing steam. This steam, in turn, condensed and trapped the volatile oil from the flower samples. Subsequently, the condensed mixture of water and essential oil was collected in a separating funnel, and the final results were obtained in an Erlenmeyer flask. To separate the essential oil from water, a separating funnel with the addition of anhydrous Na2SO4 was employed. The Na2SO4 served as a desiccant to bind water in the oil, facilitating the separation of the essential oil layer from water. The essential oil yield obtained in this research was 0.7699%. According to (HeppyYulianita, 2009), the typical yield from ylang-ylang essential oil isolation ranges from approximately 0.8% to 1%. However, the results in this study did not reach the upper end of this range, which may be attributed to regional variations that can affect the composition and quality of essential oils.

Essential Oil Quality Testing According to SNI Standards

The testing of essential oil characteristics is essential to determine the readiness of essential oil for commercial use by comparing the obtained values in the research with the SNI 06-3949-1995 standards. The research findings yielded the characteristic results of ylang-ylang essential oil, which are presented in the following table

Table 5: Essential Oil Characteristics

No.	Test Parameter	Quality Standard	Obtained Results
1	Specific Gravity	0.906 – 0.920	0.910
2	Refractive Index	1.495 – 1.504	1.495
3	Ester Value	15 - 30	20.98
4	Acid Value	0.5 – 2.0	1.6
5	Solubility in 95% Ethanol	1 : 0.5 Clear (Then clear)	1 : 0.5 Clear (Then clear)

The examination of essential oil characteristics encompassed specific gravity, refractive index, ester value, acid value, and the solubility of Ylang-Ylang essential oil in 95% ethanol. The determination of specific gravity yielded a result that aligned with the standard for Ylang-Ylang essential oil, which is 0.910, within the established quality range of 0.906 to 0.920. Specific gravity determination holds significant importance in assessing the suitability and purity of essential oils for adherence to existing standards. According to. (Baihaqi et al., n.d.), specific gravity values for essential oils typically range from 0.696 to 1.188 at 15°C. The specific gravity determination in this research aligns with Novari's findings, resulting in a value of 0.910.

Subsequently, the refractive index value was determined using an Abbe refractometer to assess the purity of

the obtained Ylang-Ylang essential oil. Essential oils containing impurity compounds, such as water, can affect their refractive index values. Higher impurity content, like water in essential oil, can lead to a lower refractive index due to the easier light refraction caused by the water content(Aisyah et al., 2016) . The results obtained from the refractive index determination of Ylang- Ylang essential oil in this research align with the quality standard, which is 1.495. The established quality standard for the refractive index of Ylang-Ylang essential oil in SNI 06-3949-1995 falls within the range of 1.495 to 1.504.

Furthermore, the ester value determination yielded a result of 20.98 mg KOH/g, which complies with the SNI requirements ranging from 15 to 30 mg KOH/g. The ester value determination involved an acid-base titration process, also known as acidimetry. Acidimetry is the determination of the base content using an acid compound. As per Wiyono and Rosid (1989), Ylang-Ylang essential oil contains esters such as valeric acid, acetic acid, benzoic acid, benzyl acetate, and benzyl benzoate, which are vital ester types in Ylang-Ylang essential oil. The higher the ester value in Ylang-Ylang essential oil, the better its quality.

Additionally, the acid value determination for Ylang-Ylang essential oil using alkalimetry resulted in a value of 1.6 mg KOH/g. This value complies with the SNI standards for the acid value of Ylang-Ylang essential oil, which ranges from 0.5 to 2.0 mg KOH/g. According to (Tarigan & Simatupang, 2019) the quality of an oil is significantly influenced by its acid value. Lower acid values indicate higher oil quality. Elevated acid values can alter the unique scent of the essential oil (Prayugo Wibowo et al., 2016).

The determination of the solubility of Ylang-Ylang essential oil in 95% ethanol resulted in a clear solution with a ratio of 1:0.5, which remained clear upon further dilution. According to (Prayugo Wibowo et al., 2016)increased solubility of the essential oil in ethanol signifies a higher content of polar compounds in the oil. The solubility of essential oil in alcohol-based solvents is influenced by the types of chemical compounds present in the oil.

GC-MS Analysis

The identification of compounds contained in essential oil can be performed through testing using gas chromatography-mass spectrometry (GC-MS) instrumentation. The results of compound identification in Ylang-Ylang essential oil in this study can be seen in the following figure:

Interpretation of the figure with percentages of areas greater than 5% can be observed in the following table:

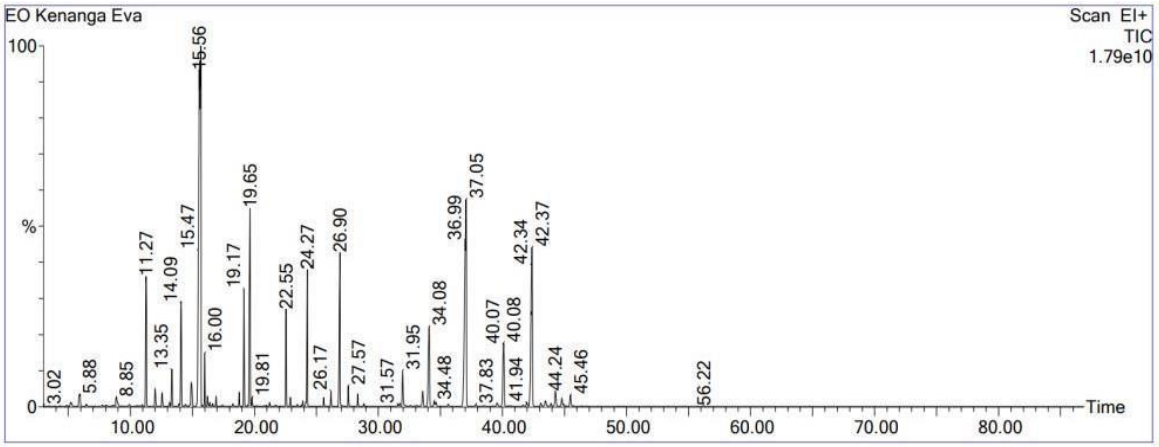

Table: 6 Compound Identification using GC-MS Instrument

No.	R.Time	Name	Area%
1.	15.675	Benzene, 1-methoxy-2-methyl-	28.695
2.	19.650	Linalool	6.436
3.	37.052	Caryophyllene	13.468
4.	42.369	ç-Muurolene	8.426

The employment of Gas Chromatography-Mass Spectrometry (GC-MS) instrumentation for compound

identification represents a foremost technique, proficient in discerning volatile substances, hydrocarbons, alcohols, esters, and both short- and long-chain acids [29]. Upon careful examination of the chromatogram displayed above, it becomes evident that a multitude of compounds has been identified within the ylang-ylang essential oil sample under investigation. However, it is noteworthy that only a select few compounds exhibit substantial percentages, as comprehensively illustrated in the tabulated data presented subsequently. Notably, the compounds boasting the most significant concentrations encompass benzene, 1-methoxy-2- methyl- (28.695%), caryophyllene (13.468%), α-muurolene (8.426%), and linalool (6.436%). These compounds hold pivotal roles as primary constituents within the composition of ylang- ylang essential oil, endowing it with its distinctive aromatic profile. It is pertinent to elucidate that caryophyllene, due to its allocation of 15 carbon atoms, is classified within the sesquiterpene category, a categorization derived from research conducted by. Moreover, several other compounds identified in this study, including linalool and α-muurolene, align with the sesquiterpene and terpenoid classifications(Rachmaniar et al., 2018). Importantly, these sesquiterpene and terpenoid compounds, prevalent within the realm of essential oils, hold the potential to impart therapeutic benefits through aromatherapeutic applications Consequently, y.lang-ylang essential oil finds extensive utilization across various industries, including cosmetics and perfumery, owing to its invigorating olfactory characteristics and the conceivable relaxation effects it offers**.**

Conclusion

Based on a series of tests conducted on ylang-ylang essential oil, several conclusions can be drawn. The yield of ylang-ylang essential oil was found to be 0.7699%, which falls within the typical range for this oil. Furthermore, quality parameters such as specific gravity and refractive index meet the standards, indicating good purity. The ester value and acid value also fall within the appropriate range, indicating suitable ester content and acidity levels in the oil. Additionally, ylang-ylang essential oil exhibits good solubility in 95% ethanol, suggesting the presence of polar compounds. Through GC-MS analysis, several major compounds were identified, including benzene, 1-methoxy-2-methyl-, caryophyllene, ç-muurolene, and linalool, which play essential roles in imparting the characteristic aroma and properties of ylang-ylang essential oil. Therefore, the ylang-ylang essential oil tested in this study can be considered to meet most quality standards and is suitable for various applications, such as cosmetics, perfumes, and aromatherapy.

Ethical statement

This study was performed with approval from the Ethics committee of the Health Polytechnic of the Ministry of Health Aceh

Reference

1. Aisyah, Y., Haryani, S., & Maulidya, R. (2016). Pengaruh Jenis Bunga Dan Waktu Pemetikan Terhadap Sifat Fisikokimia Dan Aktivitas Antibakteri Minyak Atsiri Bunga Kenanga (Cananga Odorata). Jurnal Teknologi Dan Industri Pertanian Indonesia, 8(2), 53–60. Https://Doi.Org/10.17969/Jtipi.V8i2.6398
2. Ammar, L. A., Kurniawati, B., Anggorowati, D., Cahyaningsih, A. P., & Setyawan, A. D. (2021). Ethnobotanical Study Of The Medicinal Plant By Local Communities In Karst Area Of Pacitan District, East Java, Indonesia. International Journal Of Tropical Drylands, 5(2). Https://Doi.Org/10.13057/Tropdrylands/T050205
3. Baihaqi, B., Hakim, S., Nuraida, N., Mandasari, M., & Mahfuzah, M. (N.D.). Pengaruh Konsentrasi Pelarut Dan Waktu Maserasi Terhadap Hasil Ekstraksi Oleoresin Jahe Merah (Zingiber Officinale Var. Rubrum). Jurnal Teknologi Pengolahan Pertanian, 4(2), 48–52.
4. Bunse, M., Daniels, R., Gründemann, C., Heilmann, J., Kammerer, D. R., Keusgen, M., Lindequist, U., Melzig, M. F., Morlock, G. E., Schulz, H., Schweiggert, R., Simon, M., Stintzing, F. C., & Wink, M. (2022). Essential Oils As Multicomponent Mixtures And Their Potential For Human Health And Well-Being. Frontiers In Pharmacology, 13, 956541. Https://Doi.Org/10.3389/Fphar.2022.956541/Bibtex
5. Curtis, Susan., Thomas, Pat., & Johnson, Fran. (2016). Essential Oils. Dk Publishing.
6. Donald, B. (2015). Isolasi Dan Karakterisasi Senyawa Metabolit Sekunder Dari Ekstrak Kulit Batang Kenanga (Cananga Odorata (Lam.) Hook.F. & Thomson) Aktif Sebagai Antioksidan.
7. Eka Puspa, O., Syahbanu, I., Agus Wibowo, M., & Hadari Nawawi, J. H. (2017). Uji Fitokimia Dan Toksisitas Minyak Atsiri Daun Pala (Myristica Fragans Houtt) Dari Pulau Lemukutan. Jurnal Kimia Khatulistiwa, 6(2), 1–6. Https://Jurnal.Untan.Ac.Id/Index.Php/Jkkmipa/Article/View/18699
8. Halder, D., Barik, B. B., Dasgupta, R. K., & Roy, S. D. (2018). Aroma Therapy: An Art Of Healing. Indian Research Journal Of Pharmacy And Science, 5(3), 1540–1558. Https://Doi.Org/10.21276/Irjps.2018.5.3.2
9. Harimurti, P., Prawira, J., & Hort, K. (2017). The Republic Of Indonesia Health System Review Asia Pacific Observatory On Health Systems And Policies. Health Systems In Transition, 7(1).
10. Heppyyulianita. (2009). Esterifikasi Linalool Dalam Minyak Kenanga Hasil Distilasi Bunga Kenanga (Cananga

Odorata Hook. F. & Thoms.) Dan Uji Aktivitasnya Terhadap Bakteri Staphylococcus Aureus.
11. Indrasetiawan, P., Aoki-Utsubo, C., Hanafi, M., Hartati, S. R. I., Wahyuni, T. S., Kameoka, M., Yano, Y., Hotta, H. A. K., & Hayashi, Y. (2019). Antiviral Activity Of Cananga Odorata Against Hepatitis B Virus. Kobe Journal Of Medical Sciences, 65(2), E71. Https://Pmc.Ncbi.Nlm.Nih.Gov/Articles/Pmc7012192/
12. Meisya Putri, A., Muham, A. O., Anggraini, S., Maisarmah, S., Ade, P., & Yulis, R. (2020). Analisis Kualitatif Kandungan Bunga Kenanga (Cananga Odorata) Secara Fitokimia Dengan Menggunakan Pelarut Etanol. Journal Of Research And Education Chemistry, 2(1), 43–43. Https://Doi.Org/10.25299/Jrec.2020.Vol2(1).4783
13. Mondong, F. R., Sangi, M. S., & Kumaunang, M. (2015). Skrining Fitokimia Dan Uji Aktivitas Antioksidan Ekstrak Etanol Daun Patikan Emas (Euprorbia Prunifolia Jacq.) Dan Bawang Laut (Proiphys Amboinensis (L.) Herb). Jurnal Mipa, 4(1), 81–87. Https://Doi.Org/10.35799/Jm.4.1.2015.6910
14. Munadi, Rachmin. (2020). Analisis Komponen Kimia Dan Uji Aktivitas Antioksidan Ekstrak Rimpang Jahe Merah (Zingiber Officinale Rosc. Var Rubrum). Https://Www.Academia.Edu/107601607/Analisis_Komponen_Kimia_Dan_Uji_Aktivitas_Antioksidan_Ekstrak_Rimpang_Jahe_Merah_Zingiber_Officinale_Rosc_Var_Rubrum_
15. Nugraha, A. S., & Keller, P. A. (N.D.). Revealing Indigenous Indonesian Traditional Medicine: Anti-Infective Agents.
16. Nurhayani, F. O., Wulandari, A. S., & Suharsi, T. K. (2019). Morphology And Anatomy Of The Fruit And Seed Of Cananga Odorata (Lam.) Hook.F. & Thomson. Biodiversitas Journal Of Biological Diversity, 20(11), 3199–3206. Https://Doi.Org/10.13057/Biodiv/D201112
17. Pengpid, S., & Peltzer, K. (2018). Utilization Of Traditional And Complementary Medicine In Indonesia: Results Of A National Survey In 2014-15. Complementary Therapies In Clinical Practice, 33, 156–163. Https://Doi.Org/10.1016/J.Ctcp.2018.10.006
18. Pols, H. (2009). European Physicians And Botanists, Indigenous Herbal Medicine In The Dutch East Indies, And Colonial Networks Of Mediation. East Asian Science, Technology And Society: An International Journal, 3(2–3), 173–208. Https://Doi.Org/10.1215/S12280-009-9085-6
19. Prayugo Wibowo, D., Rustamsyah, A., Kurniawan, Y., Farmasi, S. T., & Bandung, I. (2016). Karakterisasi Dan Aktivitas Repelen Minyak Atsiri Sereh Wangi (Cymbopogon Nardus L), Akar Wangi (Vetiveria Zizanoides L.), Nilam (Pogestemon Cablin), Cengkeh (Syzgium Aromaticum) Asal Kabupaten Garut Terhadap Nyamuk Aedes Aegypti Betina. Jurnal Ilmu Farmasi Dan Farmasi Klinik, 13(2), 1–6. Https://Doi.Org/10.31942/Jiffk.V13i2.1702
20. Propantoko, H., Mansur, I., & Wulandari, A. S. (2020). Studi Teknik Tradisional Budidaya Dan Produksi Kenanga Jawa (Cananga Odorata F. Macrophylla) Di Blitar. Journal Of Tropical Silviculture, 11(3), 177–182. Https://Doi.Org/10.29244/J-Siltrop.11.3.177-182
21. Rachmaniar, R.-, Kartamihardja, H.-, Sari, N. N., & Barata, T.-. (2018). Formulasi Dan Evaluasi Gel Aromaterapi Minyak Atsiri Bunga Kenanga (Cananga Odorata) Sebagai Antidepresi. Jurnal Sains Dan Teknologi Farmasi Indonesia, 4(2). Https://Doi.Org/10.58327/Jstfi.V4i2.47
22. Sharmeen, J. B., Mahomoodally, F. M., Zengin, G., & Maggi, F. (2021). Essential Oils As Natural Sources Of Fragrance Compounds For Cosmetics And Cosmeceuticals. Molecules (Basel, Switzerland), 26(3). Https://Doi.Org/10.3390/Molecules26030666
23. Suryani, C., Prasetya, E., Harsono, T., Amalia, L., Muammar, Musdary, F., Aulia, R. N., & Husna, A. (2022). Genetic And Kinship Analysis Of Kenanga (Cananga Odorata) From North Sumatra. Aip Conference Proceedings, 2659. Https://Doi.Org/10.1063/5.0116463
24. Tan, L. T. H., Lee, L. H., Yin, W. F., Chan, C. K., Abdul Kadir, H., Chan, K. G., & Goh, B. H. (2015a). Traditional Uses, Phytochemistry, And Bioactivities Of Cananga Odorata (Ylang-Ylang). Evidence-Based Complementary And Alternative Medicine : Ecam, 2015. Https://Doi.Org/10.1155/2015/896314
25. Tan, L. T. H., Lee, L. H., Yin, W. F., Chan, C. K., Abdul Kadir, H., Chan, K. G., & Goh, B. H. (2015b). Traditional Uses, Phytochemistry, And Bioactivities Of Cananga Odorata (Ylang-Ylang). Evidence-Based Complementary And Alternative Medicine, 2015. Https://Doi.Org/10.1155/2015/896314
26. Tarigan, J., & Simatupang, D. F. (2019). Uji Kualitas Minyak Goreng Bekas Pakai Dengan Penentuan Bilangan Asam, Bilangan Peroksida Dan Kadar Air.
27. Toghueo, R. M. K., Zabalgogeazcoa, I., Vázquez De Aldana, B. R., & Boyom, F. F. (2017). Enzymatic Activity Of Endophytic Fungi From The Medicinal Plants Terminalia Catappa, Terminalia Mantaly And Cananga Odorata. South African Journal Of Botany, C(109), 146–153. Https://Doi.Org/10.1016/J.Sajb.2016.12.021