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Phytochemical Screening of Gogauke Bio Oil as an Excellent Bio-Product for Natural Resource Management Solutions in Papua

Mingle A Pistanty[1*], Sarima[1], Wahyu Purwanjani[2]

[1] Universitas Cenderawasih, Jayapura, Indonesia.
[1] Universitas Cenderawsih, Jayapura, Indonesia.
[2] Universitas An Nuur, Grobogan, Indonesia.

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Corresponding Author:
Mingle A Pistanty
minglepistanty@gmail.com

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Abstract: The Potential of Papua's Gogauke for Bio-Excellent Superior Products Papua possesses abundant biodiversity, and the Provincial Government is committed to green growth and sustainable natural resource management. Based on Special Autonomy, the rights of indigenous communities to protect the forests are also recognized. Local plants are often overlooked, despite having great potential. One such plant is Gogauke (*Centella asiatica*), traditionally used by Papuans as medicine. This plant is known to have various benefits, such as anti-inflammatory properties, wound healing, and pain relief. The objective of this research is to determine the potential of *gogauke* as a natural raw material for the superior product "Bio-Excellent" through phytochemical screening of the bio-oil produced. Using an experimental method, the study shows that *Gogauke* bio-oil has very strong potential for development. Phytochemical tests prove the product is rich in secondary metabolite compounds, including Alkaloids, Flavonoids, Triterpenoids, Tannins, Phenols, Steroids, and Glycosides. This combination of compounds provides a scientific basis for broad biological activities (antioxidant, anti-inflammatory, and antifungal). Furthermore, physical parameters (water content 9.8%, yield 44.14%) and microbiological test results (TBC and YMK) indicate that the bio-oil is safe and stable, meeting the BPOM standards for natural medicinal products. Conclusion: *Gogauke* bio-oil has a superior biochemical profile and high market potential, making it a promising "Bio-Excellent" product derived from Papua's sustainably managed natural resources.

Keywords: Bio oil; Gogauke; Phytochemicals

Introduction

The preservation of natural resources in Papua is a progressive and important step that reflects a strong commitment to protecting life sources, improving the quality of life, and strengthening the economy and cultural identity of local indigenous communities. Papua is blessed with invaluable natural resources that enable sustainable management of natural resources (Smith, 2011; AR et al., 2019; Boissiere et al., 2004; Radi et al., 2023). Papua Province has a potential land area of 3,513,552,000 hectares, with a breakdown of 102,588 hectares or 2.29% already utilized and 3,410,964,000 hectares or 97.08% still untapped. The potential area of land for developing food crops and horticulture in Papua province reaches 14,269,376 Ha or 71.32% with details that have been utilized 190,632 Ha or 13.36% of which is used for rice fields 25,127 or 1.76%, yards 77,461 Ha, or 5.43% and plantations 88,044 Ha or 6.17%, while unused land area of 14,078,744 Ha or 98.66% (Papua

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Provincial Government, 2024). This shows that there is still a large opportunity for the abundance of gogouke in Papua seeing the habitat of this plant which is able to grow in various places, such as plantations, rice fields, roadsides, and between grasses can also grow in lowlands to highlands (Burhan et al., 2022; Djoko et al., 2020; Jasmansyah et al., 2020; Susetyarini et al., 2020; Bouyahya et al., 2021).

Gogouke, or Centella asiatica in Latin, has long been considered a weed by the local community (B. A. Putri et al., 2023; Sabila & Muhartono, 2020; La et al., 2020). Facing major challenges in sustainable natural resource management, one potential natural resource that has not been optimal is the gogauke plant, which is believed to have great potential in the development of phytochemical-based products (Dewi et al., 2018; Reubun et al., 2020; Susetyarini & Nurrohman, 2022). This plant is known for its bioactive compounds such as triterpenoids (asiaticoside, madecassoside), flavonoids, and saponins, which have great potential in the pharmaceutical, cosmetic, and health sectors (Prasetyo et al., 2022; Pistanty, 2022; Hussein et al., 2016). In previous studies, Gogauke has been shown to have anti-inflammatory activity, wound healing, and improve blood circulation (Singh et al., 2025; Azizah, 2022; Mohamed et al., 2020; Agustini et al., 2020). This plant grows in the forests of Papua and has great potential to be developed as a raw material for bio-oil, which is not only therapeutic but also environmentally friendly. This bio-oil has the potential to be an exclusive bio-solution that can be utilized in various sectors, from the energy industry and pharmaceuticals to agriculture (Burhan et al., 2022; Zinoviadou et al., 2009; Valeeva et al., 2019; Hyldgaard et al., 2012). In previous studies, gogauke has been shown to have anti-inflammatory activity, wound healing, and improve blood circulation (Azizah, 2022). Extracting bio-oil from local plants like Gogauke involves efficient technology to process raw materials into valuable products. Extraction technologies such as hydrodistillation and solvent extraction are common methods used in plant processing to produce essential oils (Wahyuningtyas et al., 2021; Safitri & Syafitri, 2022). Specifically, bio-oil produced from Gogauke is thought to contain phytochemicals that have the potential to be an alternative solution for environmentally friendly natural resource management and support the bioenergy industry and other nature-based products (Singh et al., 2025; Hadrian et al., 2023; Obuetibe et al., 2023). However, to date, research related to the phytochemical potential of Gogauke bio-oil as a bio-excellent product remains very limited. Furthermore, sustainable natural resource management in Papua remains a major challenge, particularly in the context of poorly managed exploitation that has the potential to damage local ecosystems (Bermawie et al., 2015). Therefore, phytochemical screening of Gogauke bio-oil is necessary to utilize its potential bioactive compounds to reduce dependence on synthetic chemicals. The phytochemical potential of gogauke can be utilized to support greener and more sustainable development in Papua, which is in line with environmental conservation efforts and local community empowerment (Botahala et al., 2020).

Method

Tools and Materials

The tools used in this study were test tubes (iwaki), stirrers (iwaki), water baths, 60-mess sieves (sieve), 1 set of hydrodistillation, pycnometer (iwaki), hotplates (bante), analytical scales (D-Scale), object glass (pyrex), separatory funnel (pyrex), Bunsen burners, ovens (memmert), sample bottles (duran), measuring flasks (iwaki), UV-Vis spectrophotometers (Hitachi), dropper pipettes, Erlenmeyer flasks, measuring cups, stirring rods, filter paper, porcelain cups, spatulas, knives, label paper.

The materials used in the study were gogauke (Centella asiatica), H_20 distillate, ethanol 96% methanol p.a (Merck), Na_2CO_3 (Merck)®, folin-ciocalteu reagent (Merck)®, gallic acid standard (sigma)®, ascorbic acid (Merck)®, quercetin (Merck)®, $AlCl_3$ (Merck)®, DPPH (sigma)®, H_2SO_4 (sigma), Dragendroff reagent (sigma), Liebermann-Burchard reagent (sigma), Mg (sigma), HCl (sigma), $FeCl_3$ (sigma), mayer (sigma), chloroform (sigma), CH_3COOH (sigma), HNO3 (sigma), Perchloric acid (sigma).

Research Stages

Making Gogauke Simplisia

Collecting Gogauke plants from various regions in Papua will be the first step in this research. Identification of locations with the highest quality Gogauke plants will be carried out to ensure that the raw materials used contain optimal bioactive compounds. Furthermore, mapping the potential of Gogauke plants in various regions of Papua is also necessary to determine the distribution of this plant.

Making Gogauke Bio oil

At this stage, efficient and environmentally friendly extraction technologies will be implemented. Hydrodistillation and extraction methods using organic solvents or green chemistry will be tested to ensure the resulting bio-oil product is of high quality and safe for use. Cleaned and finely chopped gogauke plant samples are then distilled using a steam-water distillation method. The resulting oil is then added with anhydrous Na2SO4 to obtain pure oil. Tests on the active compounds in gogauke essential oil will also be conducted to ensure its effectiveness in various applications.

Phytochemical Screening

Phytochemical screening is performed by identifying secondary metabolite compounds such as flavonoids, phenolics, tannins, alkaloids, terpenoids, and steroids. The extract is weighed, extracted with a specific solvent and method, and then subjected to TLC analysis (Depkes, 2000). Generally, chromatograms are made on silica gel plates with various types of mobile phases according to the chemical content groups as the target of analysis. Evaluation can be done by photographic documentation of the results of chromatography plate coloring with appropriate reagents. The thin chromatography plate is activated by heating it in an oven at a temperature of 50-60 0C for 30 minutes, then removed and a straight line is drawn on the plate with a distance of approximately 1 cm as the lower limit and 0.5 cm as the upper limit (Base, 2018).

Identification of Alkaloid Compounds

Identification using the filter layer chromatography method, using ethyl acetate: n-hexane (7: 3) as eluent. After that, the eluent was saturated in the chamber using filter paper. Next, the TLC plate that had been spotted with the extract was inserted into the chamber and then eluted. Observation of the appearance of the spots was carried out using 254 nm UV light, then spot detection by spraying Dragendorff reagent, then calculating the Rf value (Izza AR et al., 2019).

Identification of Flavonoid Compounds

Centella asiatica plant extract solutions were each dissolved with methanol, then spotted on a TLC plate with a stationary phase of silica gel F_{254}, then the TLC plate was inserted into a chamber containing the upper phase eluent n-hexane: ethyl acetate (1: 4) left until completely eluted. After that, the spots were observed under UV light at a wavelength of 366 nm and by spraying $AlCl_3$ and sitroborate reagent which showed a yellow-greenish color (Ahmad et al., 2015).

Identification of Triterpenoid Compounds

Prepare the mobile phase n-hexane: ethyl acetate (4:1) with a standard ratio of β-sitosterol. The mobile phase used for the identification of triterpenoid compounds is n-hexane: ethyl acetate (4:1) with the appearance of stains using an anisaldehyde acid reagent. A positive result for triterpenoids/steroids is when a purple-red or purple color appears (La et al., 2021).

Identification of Tannin Compounds

The mobile phase used to identify tannin compounds is methanol: water (6:4) with the appearance of 5% $FeCl_3$ stains, where the positive reaction formed is a black stain (La et al., 2021).

Identification of Phenol Compounds

The methanol extract solution of patikala fruit and leaves was spotted on a TLC plate and eluted using n-butanol: acetic acid: water (4:1:5) solvent, then the spots were observed under a UV lamp and sprayed with iron (III) chloride ($FeCl_3$) reagent. Positive phenol content is indicated if the stain is green, red, purple, blue, or black in color (Ahmad et al., 2015). The conditions for a good stain are that it has no tail and the distance between one spot and another is clear. The next process is analyzing Rf and comparing it with the theoretical standard Rf value (Kemenkes RI, 2017).

Bio oil safety test

Non-specific parameters are responsible for the quality and safety of a natural material. According to Rustam (2018) , non-specific parameters include:

Specific Gravity

Specific gravity is related to contamination or purity of the extract. The purpose of determining specific gravity is to provide an indication of the mass per unit volume, a specific parameter for liquid extracts and concentrated extracts that can still be poured. Specific gravity is also related to the purity of the extract and contamination (Putri, 2014).

Water Content

The water content determination parameter aims to determine the residual water content after drying or thickening the extract. Water content determines the quality and stability of the extract in subsequent dosage forms. A water content above 10% is considered risky (Pramono & Ajiastuti, 2004).

Residual Organic Solvents

The purpose of determining residual organic solvents is to determine the remaining ethanol solvent after drying. Ethanol is used as a solvent because it has lower toxicity compared to other solvents such as methanol, chloroform, hexane, etc. Safe and high-quality natural ingredients must be ensured to contain no residual organic solvents (Purgiyanti et al., 2021).

Microbial Contamination

The microbial contamination aspect aims to determine the presence of microbes that can damage the extract so that efforts can be made to prevent contamination or eliminate contamination in accordance with the permitted microbial contamination requirements (Sudimartini et al., 2022; Limarta et al., 2024; Wicaksono et al., 2025).

Data Analysis

Data processing will be carried out descriptively.

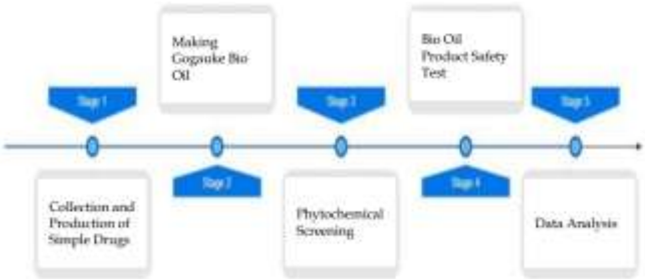

Figure 1. Research flowchart

Result and Discussion

Result

Phytochemical Test

The results obtained from the study aimed to characterize Gogauke bio-oil. The primary focus was on two critical aspects: the phytochemical profile, which identifies the presence of bioactive secondary metabolites, and safety testing, which evaluates the product's physical and microbiological parameters. These results provide an empirical basis for testing the hypothesis that Gogauke bio-oil has the potential to be a high-value natural product, or "Bio-Excellent," rooted in the sustainable use of Papua's endemic natural resources.

The methodological approach used in this study involved tube tests and Thin Layer Chromatography (TLC) for qualitative phytochemical screening, as well as a series of standard tests to determine moisture content, specific gravity, yield, Total Germ Count (TGC), and Yeast Mold Count (YMC). The analysis and interpretation presented in this chapter not only describe the raw data but also place the findings in a broader scientific context, evaluate the biological significance of the detected compounds, and critique the product's compliance with relevant regulatory standards.

Table 1. Phytochemical Test Results of Gogauke Bio Oil

Phytochemical Screening	Replication 1	Replication 2	Replication 3
Alkaloids	+	+	+
Flavonoids	+	+	+
Triterpenoids	+	+	+
Tannin	+	+	+
Phenol	+	+	+
Steroids	+	+	+
Glycosides	+	+	+

Note: The (+) sign indicates a positive result for the presence of the compound.

The test tube test was used to detect the presence of six major secondary metabolite compounds in Gogauke bio-oil. Phytochemical content analysis using TLC was used to identify the presence and distribution of major secondary metabolite compounds in Gogauke bio-oil. The test results showed a positive response for all analyzed compound groups in all three sample replicates, indicating that these compounds were present at detectable concentrations. The components analyzed in Table 1 include alkaloids, flavonoids, saponins, triterpenoids, tannins, and phenols.

Product Safety Testing

The product safety test aims to evaluate the physical and microbiological parameters of gogauke extract. The parameters tested include water content, specific gravity, yield, total bacterial count (TBC), and yeast count (YM). This safety test is essential for determining the quality and stability of the herbal extract, as well as the quality of the resulting bio-oil, as shown in Table 2.

Table 2. Results of Physical and Microbiological Parameter Testing of Gogauke Bio-oil

Security Test	Replication 1	Replication 2	Replication 3	SD	Description
Water content	9.8	9.8	9.80	0.00	< 10 (Fulfil)
Specific Gravity	0.128	0.941	0.135	0.47	Fulfil
Yield	44.14	44.14	44.14	0.00	Fulfil
ALT	1.4×10^3	1.4×10^3	1.4×10^3	0.00	(25-250) (BPOM, 2019) (Fulfil)
AKK	6.9×10^3	6.9×10^3	6.9×10^3	0.00	AKK (10-150) (BPOM, 2019) (Fulfil)

The data in Table 2 shows the results of testing the physical and microbiological parameters of Gogauke bio oil, including water content, specific gravity, yield, ALT, and AKK, which meet the requirements.

Discussion

Phytochemical Test

Phytochemical screening results confirmed the presence of alkaloids, flavonoids, triterpenoids, tannins, phenols, steroids, and glycosides in Gogauke bio-oil. This finding is highly significant because these secondary metabolites are known to have diverse biological and pharmacological functions. The simultaneous presence of these diverse classes of compounds is a strong initial indication that this bio-oil has broad therapeutic potential. The qualitative test, which showed positive results across all replicates, also indicates the consistent presence of these compounds in the product, which is an important prerequisite for future product standardization.

The identification of these compounds provides a scientific basis for projecting the potential utilization of Gogauke bio-oil.

Flavonoids and Phenols

This class of polyphenolic compounds is widely known for its potent antioxidant activity. These compounds have the ability to scavenge free radicals and reduce cell damage, which is an important mechanism in preventing premature aging and degenerative diseases. Furthermore, they also act as anti-inflammatory, antibacterial, and antifungal agents. Some of these compounds are capable of activating the Nrf2 signaling pathway, which increases the expression of endogenous antioxidant enzymes, providing more comprehensive cellular protection.

Tannin

Tannins are polyphenolic compounds with unique biological activities. Studies show that tannins have significant antifungal effects by disrupting fungal cell wall permeability, inhibiting metabolic processes, and even damaging cell membranes. This function is highly relevant as a natural plant defense mechanism and can translate into similar benefits in end products.

Saponins, Triterpenoids, and Glycosides

Triterpenoids and steroidal glycosides are often collectively referred to as saponins. This group of compounds shows great potential as pharmaceutical and nutraceutical agents. They have been shown to possess hypocholesterolemic, anticarcinogenic, hepatoprotective, hypoglycemic, immunomodulatory, and antioxidant activities. Furthermore, several studies have linked triterpenoids and related compounds to enhanced wound healing activity and stimulated collagen production, suggesting great potential for cosmetic and dermatological applications.

Alkaloids and Steroids

The presence of alkaloids and steroids also adds a bioactive dimension to the product. While some alkaloids can be toxic in high concentrations, many have important pharmacological activities. Steroids are also essential metabolites, playing a vital role in various biological functions.

This analysis shows that Gogauke bio-oil contains not just one or two bioactive compounds, but rather a synergistic combination of various groups. The combined presence of antioxidants (flavonoids, phenols), anti-inflammatory (saponins), and antifungal (tannins) gives this product a broad and comprehensive spectrum of activity. This synergistic effect can increase the overall efficacy, stability, and safety of the product compared to extracts that focus solely on a single active component. This biochemical diversity is the primary scientific basis for categorizing Gogauke bio-oil as a "Bio-Excellent" product, a product that is biologically superior and has the potential to provide holistic health benefits.

Security Test

The moisture content test results (9.8%) indicate that Gogauke bio-oil has a low moisture content and is below the recommended maximum limit (<10%). This value is very important because low moisture content significantly inhibits the growth of microorganisms and slows the degradation of chemical compounds, thereby increasing product stability during storage. The yield value (44.14%) and specific gravity also provide important information about the efficiency of the extraction process and the physical characteristics of the product. The high consistency of data between replicates (SD = 0.00) indicates that the production process is stable and replicable, which is a fundamental aspect of quality assurance.

Microbiological analysis, particularly Total Bacterial Count (TBC) and Yeast Mold Count (YMC), is crucial to ensure product safety. Research data shows an TBC value of 1.4×10^3 colonies/g and a TBC of 6.9×10^3 colonies/g. The product can be classified as a natural medicine (e.g., a traditional medicine), so the values found are far below the maximum limits permitted by BPOM Regulation No. 29 of 2023. In this regulation, the TBC limit is no more than 5×107 colonies/g and the TBC no more than 5×10^5 colonies/g. Compliance with regulations is highly dependent on the product's position in the market. Product registration strategies and the need to meet the requirements of Good Traditional Medicine Manufacturing Practices (CPOTB) to ensure consistent quality and safety on an ongoing basis.

A synthesis of all the findings confirms that Gogauke bio-oil has a strong scientific basis for development as a superior product from Papua. The concept of "Bio-Excellent," previously used in the context of bioplastics from sago and cassava for environmentally friendly products, can be adapted to define this bio-oil in a layered manner:

Biological Advantages: This product is rich in bioactive secondary metabolite compounds, which provide a strong basis for claims of pharmacological and cosmetic efficacy.

Quality and Safety Excellence: Safety tests show that this product is physically stable and has a very low level of microbiological contamination, especially if it is positioned as a natural medicine or phytopharmaceutical product.

Sustainable Advantage: Utilizing endemic resources such as Gogauke for high-value products can contribute to economic diversification, create local jobs, and encourage responsible natural resource management practices.

Overall, the available data not only confirms the potential of Gogauke bio-oil but also validates the product's viability for further development. Crucial next steps include quantitative testing to determine the specific concentration of each compound, isolation of the active compound for more detailed mechanism-of-action studies, and preclinical and clinical trials to confirm its claimed benefits and safety. These research results provide a promising prototype, demonstrating that Gogauke has real potential to become a "Bio-Excellent" product that makes a significant contribution to the people and environment of Papua.

Conclusion

Based on the research results, it can be concluded that Gogauke bio-oil has very strong potential to be developed as a superior product "Bio-Excellent". Phytochemical tests show that this product is rich in various secondary metabolite compounds, including Alkaloids, Flavonoids, Triterpenoids, Tannins, Phenols, Steroids, and Glycosides. The presence of this combination of compounds provides a solid scientific basis for its potential broad biological activities, such as antioxidant, anti-inflammatory, and antifungal. In terms of safety, Gogauke bio-oil shows promising results. Physical parameters such as water content (9.8%) and yield (44.14%) meet recommended standards. Microbiological testing results for Total Bacterial Count (TBC) and Yeast Mold Count (YMCM) demonstrate values that meet the requirements for natural medicinal products according to BPOM regulations. Therefore, this product is considered safe and stable for use. Overall, these findings not only confirm that Gogauke bio-oil has a superior biochemical profile, but also validate its marketability as a high-value product derived from Papua's natural resources in a sustainable manner.

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Author Contributions
Conceptualization, methodology, software, formal analysis, investigation, resources, data curation, writing—original draft preparation, M.A.P.; validation, writing—review and editing, visualization, supervision, project administration, S. and W.P. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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