JBIOGRITech
Journal of Biopesticide and Agriculture Technology
JBIOGRITech 1(1): 1–7
ISSN 3048-3921

Institute for Advanced Science, Social and Sustainable Future
MORALITY BEFORE KNOWLEDGE

The influence of temperature and solvent quantity on soxhlet extraction process towards total phenolic content (TPC)

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Received Date: February 21, 2024 Accepted Date: April 22, 2024

ABSTRACT
Background: Banana is a giant herbaceous plant with elongated large leaves from the Musaceae family. Several types of bananas (Musa acuminate, M. balbisiana, and M. paradisiaca) produce edible fruits that are named the same. Banana production in Indonesia is quite large. According to the Fixed Figures (ATAP) in 2013, banana production reached 6.28 million tons. **Methods:** The purpose of this research is to determine the total phenol content in kepok banana peels using the extraction method (soxhlet) with variations of solvents, namely ethanol and methanol. **Findings:** First, the material is cleaned, dried under the sun and oven, then blended into powder, made into simplisia, then extracted in a soxhlet tube, and the final step is separation. **Conclusion:** The results of the analysis obtained stated that the highest phenol content was obtained in methanol solvent, namely 0.82 mg/g GAE.

KEYWORDS: banana; influence; solvent quantity; soxhlet extraction process; temperature; total phenolic content (TPC).

1. Introduction

Phenol, also known as Hydroxybenzene, is a chemical compound with the formula C6H5OH. It typically manifests as crystals and is generally referred to any molecule that incorporates one or more hydroxyl groups directly connected to an aromatic ring. This chemical plays a significant role in various industries. In fact, approximately 37% of the global phenol production is utilized for the manufacturing of epoxy resins. These resins have a wide range of applications, including coatings, adhesives, and a variety of industrial applications. Phenol's second largest use is in the creation of phenolic resins in conjunction with formaldehyde(Wildan, 2010).These resins are predominantly used for underseal applications within the automotive industry, providing protective coatings to prevent corrosion and enhance vehicle longevity. Moreover, phenol finds its application in the pharmaceutical industry, where it is used in the production of drugs and other medicinal products. It is also employed in polymerization processes, contributing to the production of various polymers. According to Ullmann's Encyclopedia of Industrial Chemistry (2005), the

Cite This Article:
Setyowati, D, D. (2024). The influence of temperature and solvent quantity on soxhlet extraction process towards total phenolic content (TPC). *Journal of Biopesticide and Agriculture Technology*, 1(1), 1-7. https://doi.org/10.61511/jbiogritech.v1i1.2024.601

demand for phenol, particularly in Indonesia, is projected to rise due to the growth of these industries. This is evidenced by the fact that Indonesia continues to import phenol to meet its domestic needs, indicating a gap between local production and consumption. A table. 1 showing phenol import data in Indonesia from the year 2012 to 2016. This presents potential opportunities for increased domestic production or alternative sources of phenol to meet this growing demand.

Table 1. Fenol data import in Indonesia

Year	Kilograms (Kg)
2012	14.593.113
2013	16.630.449
2014	20.337.179
2015	21.134.872
2016	21.125.192

(United Nations Statistics Division, 2016)

Phenol, a compound obtained through the oxidation process of coal and cumene, is essential in various industries. However, these materials are limited, necessitating the exploration of alternative resources to support phenol's availability. One such alternative is the utilization of natural resources, particularly banana peel waste. Indonesia, a country known for its vast and diverse natural resources, is a prime location for the cultivation of bananas, one of its superior fruit commodities. The country's geographical location and climate conditions create an environment conducive to banana growth, making it a significant contributor to the global banana market. Bananas, specifically the Musa parasidiaca species, are prevalent in Indonesia due to the country's large harvest areas. With over 200 types of bananas found within its borders, Indonesia is considered a primary center for banana diversity (Agriucultural Department, 2005). This diversity is a testament to the country's rich natural resources and its capacity to support various banana cultivars (Farhaini et al., 2022).

One of the reasons bananas thrive in Indonesia is the country's climate. Bananas can grow from sea level to 1,800 meters above sea level(Metananda et al., 2023). The ideal temperature for banana growth ranges between 27 and 30 degrees Celsius, conditions commonly found in Indonesia. The country's climate, coupled with its geographical location, creates a perfect environment for bananas to flourish. Another factor contributing to the successful growth of bananas in Indonesia is the quality of its soil. Ideal for banana cultivation is a loamy, sandy soil, which is commonly found in Indonesia. This type of soil is rich, dark, and fertile, filled with organic matter, and has good moisture retention while also being well-drained. These characteristics are crucial for banana plants as they require a soil depth of 0.5 to 1 meter and a minimum slope for optimal growth(Ramirez et al., 2011). Moreover, Indonesia's soil is known for its strong water retention capabilities, an essential factor for banana growth. However, it's important to note that while bananas require a good amount of water, waterlogging or retaining too much water can be detrimental to the plant. Therefore, the soil's ability to be well-drained is just as crucial as its water retention capabilities.

In addition to the natural conditions, the use of both anorganic and organic fertilizers plays a significant role in the successful cultivation of bananas in Indonesia. Research has shown that the application of liquid organic bio-fertilizer (LOB) and inorganic fertilizers can positively affect the vegetative growth and soil microbial population of banana plants. This combination of fertilizers can enhance the soil's fertility, further promoting the growth of bananas. Banana production in Indonesia is quite large. Based on the Fixed Number (ATAP) in 2013, banana production reached 6.28 million tons. For the Asian region, Indonesia is the largest producer because 50% of Asia's banana production is produced by Indonesia. Almost all regions of Indonesia are banana-producing areas because they are supported by a suitable climate. The development and distribution of bananas are influenced by several factors, including climate, planting media, and altitude. Only 10% of banana products are exported abroad, while 90% of banana products are still used for domestic consumption.

Research on total phenol has done by many researchers. (Yusniarti et al., 2009) investigated the phenol content and antioxidant activity of methanol extracts from Caulerpa racemosa seaweed. The seaweed was processed and analyzed using Folin-Ciocalteu, DPPH, FRAP, and iron chelating assays. Findings revealed substantial phenol content and antioxidant properties. However, phenol content did not directly correlate with antioxidant activity, suggesting the influence of specific phenolic compounds and other chelating components. This highlights the complexity of antioxidant activity in natural sources(Suryani, 2012).

(Margaretta et al., n.d.) This research optimized the extraction of phenolic compounds from pandan leaves, using 96% ethanol at varying temperatures and times. The highest phenolic yield was achieved at 70°C for 5.5 hours. However, the optimal antioxidant activity, comparable to synthetic antioxidant TBHQ, was obtained at 50°C for 5.5 hours. This suggests that pandan leaf extracts have potential as natural antioxidants.

(Ajeng, 2017) explored the flavonoid content and antioxidant activity of banana peel extract. Using ethanol extraction and spectrophotometry, it was found that the extract contains flavonoids (0.79 ± 0.03% w/w). The extract showed potent antioxidant activity (IC50 of 70.41 mg/L in DPPH assay), suggesting that banana peels could be a promising source of natural antioxidants. In summary, (Ajeng, 2017) research and this research differ in their specific objectives, extraction and analytical methods used, as well as the key results and parameters investigated, although both examine extraction of phenolic compounds from banana peel. (Ajeng, 2017) focuses on flavonoids and antioxidant activity, while this research focuses on optimal extraction solvent for total phenolics.

The above literature has discussed various aspects of phenol extraction from a wide variety of fruits, as a solution to address wasted organic waste. Despite many studies on phenol extraction, research on the influence of temperature and the amount of solvent (reflux) in the Soxhlet extraction process on the Total Phenolic Content (TPC) in developing countries, such as Indonesia, is still not widely explored. The extraction of phenol from banana peels, presents a multifaceted solution that addresses economic, industrial, and environmental concerns. From an economic and industrial perspective, this approach could reduce Indonesia's reliance on imported phenol, a chemical compound with wide-ranging applications, including the production of epoxy resins. The objective of this research is to study the influence of temperature and the amount of solvent (reflux) in the Soxhlet extraction process on the Total Phenolic Content (TPC). This research will specifically focus on the total phenolic content that can be obtained from the Soxhlet extraction of Kepok banana peel. The findings from this research could contribute to the optimization of extraction conditions for maximizing the yield of phenolic compounds from Kepok banana peel. Simultaneously, this approach offers substantial environmental benefits. It promotes waste reduction and resource efficiency by transforming banana peels from waste into valuable raw material. It also reduces dependence on fossil fuels, as traditional phenol production involves petroleum products. The local sourcing of banana peels minimizes the environmental impact associated with transportation of raw materials. Furthermore, it could encourage sustainable farming practices, as banana waste becomes an additional source of income for farmers (Putra et al., 2021).

In essence, the exploration of banana peels as an alternative and renewable source of phenol aligns with the principles of a circular economy and sustainability. It represents a win-win situation, contributing to environmental conservation while supporting the development of the chemical industry in Indonesia. This research could provide a framework for scaling up extraction, paving the way for a sustainable and economically beneficial solution for both the agricultural and chemical industries in Indonesia.

2. Methods

2.1 Sample Preparation

This study used kepok banana fruit, Ethanol 96%, Methanol 96%, folin-ciocalteu reagent, sodium carbonate, and distilled water. This research was conducted at Bhayangkara University Laboratory, Jakarta.

2.2 Working Procedures

The preparation stage begins with obtaining the skin of kepok bananas from fried banana traders in the North Bekasi area. The banana skins are then sorted, separating the good skins from the damaged ones. The sorted banana skins are cleaned by washing them with running water, so that the remaining dirt attached can dissolve in the water. After washing, the banana skins are drained and sun-dried under the sun for 5 hours. Then, the drying process is continued by oven-drying the banana skins for 3 hours at a temperature of 90°C. The dried banana skins are then resized using a blender. The final step is to create a casing using filter paper, weigh a sample of 70 grams and put it into the casing, then tie it with a string.

The extraction process begins by applying vaseline to each soxhletation connector. After that, the soxhletation device is installed. The casing or simplicia is then inserted into the soxhlet tube. Each solvent as much as 500 ml is inserted until it drops into the flat-bottomed flask. The flat-bottomed flask is then heated using a hotplate at a temperature of 200°C. This process is continued by waiting until the determined number of refluxes is reached, in this study the determined number of refluxes is 3 times. The final stage in this process is separating the solvent from the extract using the soxhletation method.

2.3 Analyze Sample

The analysis of total phenol content in the skin of kepok bananas is carried out by measuring the absorbance of the sample using a UV-VIS spectrophotometer. Several treatments are required, which require several reagents. One of them uses Folin Ciocalteu reagent as a reactant.

3. Result and Discussion

Table 2. Total phenol content of Kepok Banana Fruit Peel Extract (mg/g GAE bk)

Concentration of Solution Phenol Standard (50 ppm)	Absorbance (Ethanol Solvent)	Absorbance (Methanol Solvent)
0,5	0,44	0,44
1	0,44	0,71
2	0,44	0,76
5	0,45	0,82

In this study, two solvents were employed: ethanol and methanol. The table provided offers a representation of the measurement outcomes of the solution’s absorbance, which is based on the concentration of the standard phenol solution. Ethanol was chosen as a solvent for several reasons. Firstly, it is known for its hygienic properties, making it an ideal choice for the extraction of phenolic antioxidants, as noted by Moure et al., 2001. Secondly, ethanol is readily available, which makes it a practical choice for such studies. Furthermore, ethanol is a non-toxic compound. This characteristic is crucial as it ensures the safety of the substance for consumption. Lastly, the separation of ethanol from the extract is straightforward and can be achieved through evaporation alone, as stated by Suryani, 2012. Methanol, on the other hand, is a chemical compound with the formula CH3OH. It is the simplest form of alcohol and is also referred to as methyl alcohol, wood alcohol, or spirit. Methanol was utilized as a solvent in this study due to its volatile nature, as pointed out by Maulida, 2013. This volatility allows for an easy separation process with the extract, which can be accomplished with evaporation alone (Sa'adawisna & Putra, 2023).

The determination of the total phenol content in the banana peel was conducted using the Follin Ciocalteu reagent. This reagent was selected because phenolic compounds can react with Follin Ciocalteu to form a colored solution. This colored solution can then be measured for its absorbance. The principle of this method lies in the formation of a blue-colored complex that can be measured at a wavelength of 765 nm. This reagent has the ability to oxidize phenolate (alkali salt) or phenolic-hydroxy groups, thereby reducing the heteropoly acid (phosphomolybdate-phosphotungstate) present in the Follin Ciocalteu reagent into a molybdenum-tungsten complex, as explained by Susanti, 2012. Na2CO3 is required to provide a basic condition to the mixture. This is because phenolic compounds react with the Follin Ciocalteu reagent only in a basic environment. This condition is necessary to allow the dissociation of protons in phenolic compounds into phenolate ions.The hydroxyl group in phenolic compounds reacts with the Follin Ciocalteu reagent to form a blue-colored molybdenum-tungsten complex. This complex can be detected with a spectrophotometer, providing a reliable method for measuring the total phenol content in the banana peel.

4. Conclusion

Based on analysis of the total phenol content in the skin of the kepok banana, it can be concluded that the optimal condition for the extraction of phenolic components is in methanol solvent with a concentration of 96%. Under these conditions, a banana peel extract was obtained with a phenol content of 0.82 mg/g GAE.

Author Contribution

All author contributed fully to the writing of this article.

Funding

This research did not use external funding.

Ethical Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Conflicts of Interest

The author declare no conflict of interest.

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