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A Literature Review

The Potential of Banana Peel Waste as a Base Ingredient for Lip Balm

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Abstrack : Banana peel is an organic waste that is abundantly available but have not been optimally utilized, even though it is known to contain bioactive compounds with antioxidant potential. One variety with high antioxidant activity is the peel of banana raja (Musa paradisiaca). This study aimed to review the potential of banana raja peel waste as an active antioxidant ingredient in lip balm formulations based on a literature review. The method used was a literature review by analyzing scientific articles, journals, and books obtained from Google Scholar, published between 2021 and 2025. The results showed that banana raja peel contains flavonoids, phenolic compounds, tannins, and alkaloids, which contribute to its very strong antioxidant activity. Antioxidant activity was evaluated using several methods, including DPPH, ABTS, and FRAP, with reported IC_{50} values of banana raja peel classified as very strong (<50 ppm). Several studies on lip balm formulations containing banana raja peel extract reported the lowest IC_{50} value of 10.887 ppm at a 7.5% extract concentration using the DPPH method, indicating high antioxidant effectiveness. Based on these findings, banana raja peel waste has great potential to be developed as an active antioxidant ingredient in safe, valuable, and environmentally friendly lip balm formulations.

1. INTRODUCTION

Geographically, Indonesia is an agricultural country with fairly fertile soil. This factor greatly helps Indonesia increase its agricultural yield, one of which is banana cultivation. Banana plants are classified as horticultural crops and are one of the country's best export commodities with great potential. This plant can bear fruit at any time, not just during certain seasons, and has many benefits. Parts such as the roots, stems, leaves, and even the peel can be utilized. However, most banana peels are still considered agricultural waste that is simply discarded, often causing environmental pollution. Therefore, it is necessary to find solutions on how to process this waste into specific products (Maksum, Mursyidah, and Blongkod 2024).

Bananas are one of the agricultural commodities widely cultivated in various countries, including Indonesia. According to the Central Statistics Agency (BPS), banana production in Indonesia in 2022 reached 9.60 million tons, an increase of 9.79% compared to the previous year's 8.74 million tons. One of the provinces that is the largest banana producer is Gorontalo with a production of 4,600 tons. Bananas are a very popular fruit and are widely consumed throughout the world, so they have great potential to be developed in the context of zero waste processing. However, the fruit processing industry generally produces large amounts of waste, including from bananas. This waste, such as peels, stems, and unused parts of the bunch, is often ignored or disposed of in ways that are not environmentally friendly (Marpaung et al. 2024)

Bananas (Musa paradisiaca) are the most widely consumed fruit in Indonesia. They can be eaten raw or processed into various foods. The low price of bananas makes them popular among all walks of life. In addition, bananas also contain good nutrients, such as vitamins, minerals, and carbohydrates. Bananas are known as one of the plants that are very rich in antioxidant compounds, which play an important role in fighting free radicals and supporting human health. Interestingly, banana peels, such as those

from the raja banana, contain higher concentrations of antioxidants than the fruit itself, making them a potentially valuable waste product for medical or pharmaceutical use. Demand for fruits continues to increase due to the growing economy and awareness of the health benefits of fruits (Sains and Kes 2023).

Antioxidants are substances that help protect the body's cells from damage caused by free radicals, which arise as a result of oxidative stress. These substances also play a role in converting free radicals into metabolic byproducts, which are then excreted by the body. Eating fruits and vegetables rich in antioxidants can reduce the risk of diseases triggered by free radicals (Jideani et al. 2021)

Measuring antioxidant activity can reveal different properties of antioxidants in a sample. There are several methods that can be used to measure total antioxidant properties, but no single method is considered perfect. Different methods of measuring antioxidant activity can reveal different mechanisms of antioxidant action. Some methods that can be used to measure antioxidant activity are DPPH (2,2-diphenyl-1-picrylhydrazil), ABTS (2,2-azinobis (3-ethyl-benzothiazoline-6-sulfonate)), and FRAP (Ferric Reducing Antioxidant Power). These three methods work on the same principle, namely the ability of antioxidant compounds to reduce free radicals or oxidants. The difference lies in the type of free radicals used, namely ABTS and DPPH, while FRAP tests the ability of antioxidant compounds to reduce Ferri, which is an oxidizing agent.

Methods for testing antioxidant activity in plants can be carried out in various ways. However, in practice, these methods are divided based on their mechanism of action, namely electron transfer and hydrogen atom transfer. Hydrogen atom transfer (HAT)-based methods are used to measure antioxidant capacity by capturing free radicals through hydrogen atom donation. Examples of these methods include ORAC, TRAP, β-Carotene bleaching assay, and others. Meanwhile, methods based on electron transfer (ET) are used to measure antioxidant capacity in reducing free radicals through electron transfer. Examples of these methods include FRAP, CUPRAC, FIC, DMPD, and others. The DPPH and ABTS methods are used with both mechanisms, hydrogen atom transfer (HAT) and electron transfer (ET) (Theafelicia and Wulan 2023).

Thus, the use of banana peel waste as research material is a strategic step in optimizing the potential of local resources that have been underutilized. This innovation not only contributes to the reduction of organic waste, but also manifests itself through the creation of lip balm from the use of banana peel waste that is useful, safe, and environmentally friendly, so that it is expected to provide benefits to the community and support sustainable development in Indonesia.

2. LITERATURE

Banana (Musa spp.), particularly its peel a major agricultural waste comprising 30-40% of fruit weight offers untapped potential in cosmeceuticals due to rich bioactive compounds. Banana peels contain high levels of bioactive metabolites, including 42.79-64.78% moisture, 7.22-15.89% protein, and polysaccharides like pectin that act as humectants. Key phytochemicals include flavonoids (rutin, catechin), phenolic acids (ferulic acid, gallocatechin), and flavan-3-ols (proanthocyanidins), alongside dopamine and L-DOPA contributing to bioactivity. These compounds vary by cultivar, with Cavendish peels showing superior phenolic content (up to 50 mg/g).

Antioxidants are substances that donate electrons and act as inhibitors that can slow down or prevent the interaction between free radicals and target molecules. One plant that contains antioxidants is the plantain. Plantain peel contains higher antioxidants than the fruit flesh. Plantains are generally used for their fruit and the peel is discarded. The use of banana peel (Musa spp.) in Indonesia is limited, as a mixture of animal feed (20-30%), as well as manure and compost (60-70%).

Lip balm is a semi-solid cosmetic product that is applied to the lips with the main purpose of moisturizing and protecting the lips from dryness, irritation, and environmental influences such as UV rays and dry air. Lips have a thin skin structure and are prone to moisture loss, so a preparation is needed that can form an occlusive and emollient protective layer to maintain moisture and prevent chapped lips.

In lip balm formulations, the main components often include wax as a solid base, vegetable oils as moisturizers, and additional

active ingredients such as antioxidants or UV filters to enhance its protective function. Research shows that lip balm not only provides moisture but can also help improve dry lips through a mixture of natural ingredients such as oils and plant extracts that have antioxidant activity, thus providing cosmetic benefits as well as lip skin care. Studies of various lip balm formulations in the literature confirm that these products must meet physical quality and stability standards to be effective in their protective and therapeutic functions.

3. METHOD

In writing this review article, the method used was to summarize and review literature from various sources through Google Scholar. This was done by examining and studying several articles, journals, and books, then summarizing their main points. After that, the author drew conclusions and presented data obtained from various studies. The articles and journals used were sourced from the topic of the potential of banana peel waste as a base material for lip balm, published between 2021 and 2025.

4. RESULTS AND DISCUSSION

Research on plantain peel is still limited, but its waste can be used as a good herbal medicine ingredient. Previous studies have found that banana peel extract contains compounds such as alkaloids, saponins, tannins, and flavonoids. The presence of chemicals in plants such as phenols and flavonoids indicates the possibility of antioxidant activity that can help prevent disease through free radical scavenging activity (Ade, Yulis, and Sari 2020).

Antioxidants are substances that help protect the body's cells from damage caused by free radicals, which arise as a result of oxidative stress. These substances also play a role in converting free radicals into metabolic byproducts, which are then excreted by the body. Eating fruits and vegetables rich in antioxidants can reduce the risk of diseases triggered by free radicals.

Previous research comparing ABTS and DPPH antioxidant tests on popular antioxidant-rich foods in the United States showed that the ABTS method was better at indicating the amount of antioxidants present in various types of food than the DPPH method. The study also stated that the FRAP method had a weaker correlation than the DPPH, ABTS, and ORAC methods. In addition, antioxidant tests using the DPPH and ABTS methods were able to detect strong antioxidant content in fruit and beverage samples.

The working principle of the ABTS method is to measure the antioxidant capacity in stabilizing free radicals, which can be seen from the color change. The blue-green color of the ABTS+ cation radical will change to a colorless non-radical form after being reduced by antioxidants. The ability of antioxidants to reduce ABTS is measured using a spectrophotometer at a wavelength of 734 nm (Sukweenadhi et al. 2020). The reduction reaction of ABTS from free radical compounds can be seen in Figure 1.

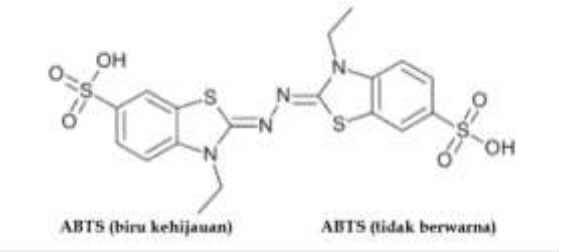

Figure 1. Reduction of ABTS by Free Radical Scavengers (Antioxidants) (Theafelicia & Wulan, 2023)

The DPPH method works through oxidation-reduction reactions. DPPH is a synthetic free radical that is soluble in polar substances such as ethanol and methanol, as explained by Malik and his team in 2017. Antioxidant compounds react with DPPH by providing hydrogen atoms as donors, electron pairs.

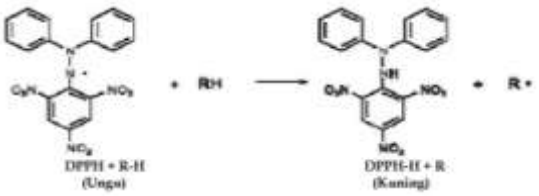

Figure 2. DPPH reduction by free radical scavenger compounds (antioxidants) (Theafelicia & Wulan, 2023)

The FRAP (Ferric Reducing Antioxidant Power) method works by converting ferroin analog,

which is the Fe3+ complex of tripyridyl triazine Fe(TPTZ)3+, into the Fe(TPTZ)2+ complex, which is bright blue in color due to the presence of antioxidant compounds in acidic conditions. The results are measured at a wavelength of 593 nm (Dontha, 2016). The colorless FRAP reagent consists of a mixture of TPTZ and FeCl3.6H2O, which is used to form the Fe3+ complex compound (Choirunnisa et al., 2016). The FRAP method works by inactivating free radicals through electron transfer (Jayanthi dan Lalitha, 2011). The reduction reaction from the ferroin analog Fe3+ complex to the Fe(TPTZ)2+ complex can be seen in Figure 3

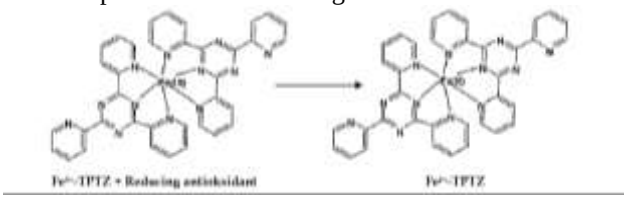

Figure 3. Reduction of Fe^{3+} to Fe^{2+} (Theafelicia & Wulan, 2023)

Table 1. Antioxidant categories based on IC_{50} in various types of banana peel

Name Of Banana	IC50 value	Category
Pisang Raja	2,690 ppm	Very strong
Pisang Kepok	554,68 ppm	Very weak
Pisang Emas	13,332 ppm	Very strong
Pisang Goroho	265, 31 ppm	Very weak

Table 1 shows that the IC50 value of plantain peel extract is 2,690 ppm. A compound is considered a very strong antioxidant if its IC50 value is less than 50 mg/L, strong if its IC50 value is 50-100 mg/L, moderate if its IC50 value is 100-150 mg/L, weak if its IC50 value is between 150-200 mg/L, and very weak if its IC50 value is more than 200 mg/L. The very strong antioxidant activity is due to the fact that banana peel contains many bioactive compounds such as flavonoids (Saputri, Nawangsari, and Samodra 2022).

The antioxidant activity of ketip banana peel, also known as kepok banana, was tested using the DPPH method. The IC50 value is the amount of antioxidant needed to stabilize 50% of DPPH. The higher the antioxidant activity, the lower the IC50 value. From the curve, the equation y=0.0911x – 0.5456 and an R2 value of 0.9821 were obtained. From this equation, it is known that the antioxidant activity of Ketip banana peel extract with ethanol solvent is very weak, because the IC50 value is only 554.84 ppm. This means that 554.84 ppm of extract is needed to reduce 50% of DPPH radicals. Antioxidant activity is considered very strong if the IC50 is less than 50 ppm. If the IC50 is between 50-100 ppm, the activity is considered strong. If the IC50 is between 100-150 ppm, the activity is moderate. If the IC50 is between 150-200 ppm, the activity is weak. Meanwhile, if the IC50 is more than 200 ppm, the activity is very weak (Bahri et al. 2025).

The antioxidant activity of golden banana peel extract was tested using the DPPH method at concentrations of 10, 20, 30, 40, and 50 ppm. The results showed that the highest percentage of free radical inhibition was 62.941% at a concentration of 50 ppm, as evidenced by an IC50 value of 14. The ethanol extract of golden banana peel had an IC50 value of 13.322 ppm. Based on the classification of antioxidants according to IC50 values, this extract falls into the category of very strong antioxidants because the IC50 value is within the range that indicates such strength (Ayuningsih, Septiarini, and Veranita 2024).

The antioxidant activity of goroho banana peel was tested using the UV-Vis spectrophotometry method at a wavelength of 517 nm. The absorbance values of the control and samples were used to calculate the percentage (%) of antioxidant activity. The DPPH method is one of the quantitative methods used to determine the antioxidant capacity of goroho banana peel. This method was chosen because it is simple, easy, fast, sensitive, and requires only a small amount of sample. The IC50 value of goroho banana peel extract was 265.31 ppm. This IC50 value indicates that the antioxidant activity of goroho banana peel extract is in the very weak category (Qonitah, Fajarwati, and Ahwan 2023).

Banana peel can be used as a lip moisturizer because it contains vitamins C and E as well as high antioxidants to help moisturize, nourish, and protect the skin of the lips from damage caused by free radicals (Maugin et al. 2024).

Table 2. Results of Literature Review on Formulation and Antioxidant Testing of Lip Balm from Banana Peel

Researcher	Extraction Method / Solvent	Anti-oxidant Assay Method	Result
(Yuliatika et al., 2023)	Maceration / 96% Ethanol	ABTS	A 20% concentration of banana peel (*Musa paradisiaca)* extract showed antioxidant activity of 24,850 ppm.
(Pusmarani et al., 2023)	Maceration / Methanol	DPPH	A 7,5% concentration of banana peel extract showed an IC_{50} value of 10,887 ppm.

Research conducted by Yuliatika and her team in 2023 successfully produced ethanol extract from plantain peel (Musa paradisiaca sapientum). The extraction was carried out using the maceration method and 96% ethanol solvent. The antioxidant activity test results showed an IC50 value of 24,850 ppm with an extract concentration of 20%, and the activity category was classified as very strong. The antioxidant test method used was ABTS. In the formulation, the ingredients used included plantain peel extract with concentrations varying from 10%, 15%, and 20%, banana essence, beeswax, vaseline album, potassium persulfate, plantain peel, methanol, methyl paraben, olive oil, ABTS reagent, cetyl alcohol, propylene glycol, vitamin C, and oleum cacao.

Research conducted by Pusmarani et al., 2023 successfully produced methanol extract from plantain peel (Musa paradisiaca sapientum). Extraction was carried out using the maceration method and methanol solvent. The antioxidant activity test results showed an IC50 value of 10.887 ppm with an extract concentration of 7.5%, and the activity category was classified as very strong. The antioxidant test method used was DPPH. In the formulation, the ingredients used included methanol extract of plantain peel with varying concentrations of 5%, 7.5%, and 10%, banana essence, methanol, propylene glycol, cera alba, oleum ricini, nipagin, butylated hydroxytoluene (BHT), and oleum cacao.

The ABTS and DPPH methods each have their own advantages. The ABTS method can be used in water-based or organic systems, has a faster reaction time, and can work at various pH levels. However, this method is quite sensitive to light and requires a long incubation time, namely 12 to 16 hours in dark conditions. Meanwhile, the DPPH method can be used for both solid and liquid samples, but it is not specific to certain types of antioxidants. This method measures the general antioxidant capacity by observing the electron capture reaction by DPPH from the antioxidant material (Theafelicia and Wulan 2023).

5. CONCLUSION

Several studies have found that one banana plant has several varieties, including plantains, kepok bananas, golden bananas, and goroho bananas. Based on the results of antioxidant activity testing on these four types of bananas, it was found that plantains have the highest antioxidant activity compared to other varieties.

Based on the results of a literature review, it was found that the raja banana plant can be used as an active ingredient in lip balm formulations as an antioxidant. From research conducted by Yuliatika and her team in 2023, the lowest IC50 value obtained was 24.850 ppm, which is classified as very strong at a concentration of 20%. Meanwhile, research conducted by Pusmarani et al. (2023) found the lowest IC50 value of 10.887 ppm, which is classified as very strong at a concentration of 7.5%. Therefore, it can be concluded that the research conducted by Pusmarani et al. (2023) provided the most significant results with an IC50 value of 10.887 ppm. This result is categorized as very strong, where the data was obtained using the methanol maceration method and DPPH analysis with a concentration of 7.5%.

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