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Dried samples characterization and determination of total phenol and flavonoid of ethanol extract from *Musa paradisiaca* l. fruit peel

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Abstract

Background: Bananas are a widely consumed food in Indonesia. However, after consuming bananas, the skin is typically discarded since it is seen as useless or of no use. The phenolic and flavonoid compounds contained in banana peel have many health benefits.

Aim: The purpose of this study was to characterize dried samples and investigate the phenol and flavonoid content of the peel of *Musa paradisiaca* L.

Method: The determination of dried samples' characteristics, including water content, water-soluble extract content, ethanol-soluble extract content, total ash content, and acid-insoluble ash content. The extraction of peels was performed by maceration with 70% ethanol. Using UV-Vis spectrophotometry, the phenolic and flavonoid content of a sample was determined. Total phenol is given as gallic acid equivalent (GAE) (mg/g), whereas total flavonoids are expressed as quercetin equivalent (QE) (mg/g).

Results: The results indicated that the dried form of banana peel exhibits a number of characteristics that match the standards. The flavonoid concentration was 10.92 mg QE per gram of extract, whereas the total phenol concentration was 47.82 mg GAE per gram of extract.

Conclusion: The characteristics of dried samples met the standards. In addition, the peel extract's total phenol and flavonoid content was 47.82 ± 2.61 GAE/g extract and 10.92 ± 0.54 mg QE/g extract, respectively.

Keywords: Banana Peel; Total Phenol; Total Flavonoid; Characterization

1. Introduction

Fruits and vegetables are considered essential components of a healthy diet. It is known that they lessen the risk of various chronic diseases. Fruits and vegetables contain considerable levels of bioactive compounds that can potentially treat cardiovascular disease and reduce cancer mortality and morbidity [1]. Fruits and vegetable wastes and their byproducts are produced in large quantities during industrial processing and, as a result, pose a severe environmental hazard [2]. Peels of fruits and vegetables are the most abundant byproducts obtained during the processing of various fruits, and studies indicate that these peels are rich in polyphenols, carotenoids, and other bioactive chemicals that have positive effects on human health [3], with various components with antibacterial, antioxidant, and anticancer properties

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[4]. Bananas are exceptional plants in Indonesia, and numerous bananas are grown domestically. Its output results surpass those of competing products. The production of bananas in Indonesia in 2013 was 5,351,126 tons, which was more than the production of other fruits [5]. Bananas' phytochemical and pharmacological properties remain undocumented, and there is no comprehensive reference available. Although it is still restricted to fruits, other pieces such as fruit peels, stems, leaves, and roots, as well as banana peels, are still considered minor amounts of processing waste. Banana peels have numerous benefits, but the community rarely utilizes them. Banana peel can be utilized to alleviate and treat painful wounds, itchy skin, warts, wound healing, and fertility [6]. Even banana peels are used to remove heavy metals from the air, particularly lead (Pb) and copper (Cu) [7]. Flavonoids and other phenolic substances are known as plants' secondary metabolites, including an aromatic ring with at least one hydroxyl group [8]. More than 8000 phenolic chemicals that occur naturally in plants have been identified [8]. It is highly intriguing to observe that fifty per cent of these phenolic molecules are flavonoids appearing as aglycone, glycosides, and methylated derivatives [9]. To explore the chemical composition and bioactive components in banana peel, the flavonoid and phenol compound concentrations were determined. In addition, the characterization of the dried sample is conducted.

2. Materials and Methods

2.1. Materials

The materials used in this study were banana fruit peels collected from Siguci Village, Deli Serdang district, with the Latin name *Musa paradisiaca* L. Other materials used were toluene (Merck), chloroform (Merck), ethanol 96% (Merck), ethanol 70% p.a, NaCl, methanol p.a, Folin Ciocalteu 10%, 20%, Sodium Acetate 10%, AlCl3 10%, NaOH 1 M, gallic acid (Merck), quercetin (Merck).

2.2. Sample Preparation

Peels were cleaned with running water, drained at room temperature, and then dried at 40-50°C in a drying cabinet. Then, the samples were pulverized using a blender, placed in a plastic container to limit the influence of moisture and other contaminants, and then stored at room temperature [10].

2.3. Determination of Water Content

The Azeotropy method is used to determine the water content of a sample (toluene distillation). In a round-bottom flask, 200 mL of toluene and 2 mL of distilled water were combined and distilled for two hours. After cooling the toluene for 30 minutes, the water volume in the receiving tube was measured. Carefully weighed 5 g of dried samples powder is added to the flask, which is then heated for 15 minutes. After the toluene begins to boil, the drip rate is adjusted to around two drops per second until the majority of the water has evaporated, at which point it is increased to 4 drops per second. After all the water has been distilled, the cooler's interior is cleaned with toluene that has been soaked. After 5 minutes of continuing distillation, the receiving tube was allowed to cool to ambient temperature. After the water and toluene have entirely separated, the water volume is measured in accordance with the material's water content. Determination of water content was performed three times [11].

2.4. Determination of Water-Soluble Extract Content

5 g of dried samples powder was macerated for 24 hours in 100 mL of chloroform water (2.5 mL of chloroform in 1000 mL of distilled water) in a plugged flask while occasionally shaking for the first 6 hours, then left for 18 hours, then filtered. Then, 20 mL of the filtrate was evaporated to dryness in a flat-bottomed shallow cup which was heated to 105 °C and tared. The residue was heated in the oven at 105 °C until a constant weight was obtained, and the water-soluble extract was determined three times. Then the water-soluble essence content was calculated [11].

2.5. Determination of Ethanol Soluble Extract Content

As much as 5 g of the dried powder was macerated for 24 hours with 100 mL of 96% ethanol using a plugged flask while occasionally shaking for the first 6 hours, then left for 18 hours. The extract was then filtered, and 20 mL of the filtrate was pipetted, and evaporated to dryness in a shallow, flat-bottomed cup that had been heated to 105 °C. The residue was heated at 105 °C until a constant weight was obtained, and the ethanol-soluble extract was determined three times. Then the ethanol-soluble essence was calculated [11].

2.6. Determination of Total Ash Content

As much as 2-3 g of dried powder that has been crushed and weighed carefully was put into a silicate crucible that has been heated and tared, then flattened. The crucible was heated slowly at 800 ± 25 °C until the charcoal ran out, then

cooled and weighed until a constant weight was obtained. Determination of total ash content was carried out in three repetitions. The entire ash content is calculated in per cent of the dried material [11].

2.7. Determination of Acid Insoluble Ash Content

The ash obtained in the determination of the total ash content was boiled in 25 mL of 2 N hydrochloric acids for 5 minutes, the part that did not dissolve in the acid was collected, filtered through an ash-free filter paper and then washed with hot water, then put in a crucible and heated at a temperature of 800 ± 25 °C until the weight remained unchanged. Determination of acid insoluble ash content was carried out in three repetitions. The acid-insoluble ash content is calculated for air-dried materials [11].

2.8. Banana Peel Extraction

The peels were extracted using the maceration process. 500 g of peel-dried samples powder was placed in an Erlenmeyer, then 5000 ml of 70% p.a. ethanol solution was added, covered with aluminium foil, and left for 18 hours with intermittent stirring during the first 6 hours. After 18 hours of soaking, the mixture was filtered through filter paper. The residue was then subjected to maceration again using the same solvent, but with a solvent volume that was half that of the initial screening. All filtrate was collected and condensed using a rotary evaporator to produce a thick extract of peel [11].

2.9. Determination of Total Phenol Levels

Extract with a concentration of 1 mg/mL or equivalent to 10 mg in 10 mL of methanol was used in the analysis. A total of 0.5 mL of the extract, which had been dissolved in methanol was taken, added with 2.5 mL of 10% Folin Ciocalteu reagent dissolved in water, and added with 2.5 mL of 20%. The blank used was a mixture of 0.5 mL methanol, 2.5 mL Folin Ciocalteu reagent dissolved in water, and 2.5 mL 20%. The sample was then incubated at 45 °C for 45 minutes. Repetitions were carried out three times and absorbance measurement was carried out in the wavelength range of 400 nm - 800 nm. The same procedure was carried out to prepare the gallic acid standard curve. Based on the absorbance measurement, the total phenol can be calculated from the standard curve, the total phenol extract was shown in gallic acid equivalent (GAE) (mg/g) with the formula as follow:

$$\text{Total phenol GAE} = c\ (V/m)$$

Information:
c = concentration of total phenol from a standard curve of gallic acid (mg/L)
V = extract volume (L)
m = extract weight (g) [12]

2.10. Determination of Total Flavonoid Levels

As much as 10 mg of the extract was dissolved in 10 mL of distilled water, and then 5 mL of the extract solution was taken and added with 0.3 mL of 10% Sodium Acetate. Next, the mixed extract was added with 0.3 mL of 10% AlC dissolved in methanol and incubated at room temperature for 5 minutes. After incubation, 2 mL of 1 M NaOH was added, and distilled water the added up to 10 mL. Measurements were repeated three times, and the determination of total flavonoids was expressed in quercetin equivalent (QE) (mg/g) with the formula below.

$$\text{Total flavonoids QE} = c\ (V/m)$$

Information:
c = concentration of total flavonoids from quercetin standard curve (mg/L)
V = extract volume (L)
m = extract weight (g) [13].

3. Results and Discussion

3.1. Characterization of dried samples

The characterization of dried samples powder from banana fruit peel (*Musa paradisiaca* L.) includes water content, water-soluble extract content, ethanol-soluble extract content, ash content, and acid-insoluble ash content. The results of dried peels characterization can be seen in Table 1.

Table 1 Characterization of Dried Banana Fruit Peels

No	Parameter	Concentration (%)
1.	Water content	9.21 ± 1.18
2.	Water-Soluble Extract Content	48.85 ± 1.07
3.	Ethanol-Soluble Extract Content	21.24 ± 0.69
4.	Total Ash Content	12.30 ± 0.31
5.	Acid-Insoluble Ash Content	0.58 ± 0.08

The water content of the dried samples is examined to determine the amount of water contained in the dried samples and the quality of the dried samples because the moisture content is related to the possibility of mold or mildew growth. The results of determining the water content were obtained less than 10%, namely 9.21%. Moisture content that exceeds 10% can be a good medium for the growth of microbes, fungi, or insects so that it can accelerate damage to dried samples [14]. Determination of the essence content of dried samples powder was carried out using two solvents, water and ethanol. Determination of the water-soluble essence content is to determine the levels of polar chemical compounds contained in dried samples, while the ethanol-soluble extract levels are carried out to determine the levels of soluble compounds in ethanol, both polar and non-polar compounds. The result of the water-soluble extract in the peel-dried samples was 48.85% while the ethanol-soluble extract in the peel-dried samples was 21.24%. This shows that the dried samples of peel contain more polar compounds than non-polar compounds.

Determination of the total ash content of peel-dried samples showed a total ash content of 12.30% and an acid-insoluble ash content of 0.58%. The determination of ash content is intended to determine the internal mineral content (physiological ash) derived from plant tissue contained in dried samples. The extraction of 500 g of dried powder from dried peel using 70% ethanol solvent resulting a viscous extract of 158.13 g with a yield of 31.62% w/w. Yield compared the extract weight with the weight of the dried sample used.

3.2. Total Phenol Concentration

The results of determining the total phenolic content of the ethanol extract of banana peels can be seen in Table 2.

Table 2 Results of Total Phenol Levels in the Ethanol Extract of Peels

Weight (g)	Volume (mL)	Absorbance	Concentration (µg/mL)	Concentration (mgGAE/g extract)	Concentration Mean (mgGAE/g extract)
0.0259	25	0.769	46.75	45.13	47.82 ± 2.61
0.0257	25	0.650	51.76	50.35	
0.0256	25	0.618	49.13	47.98	

Measurement of the total phenolic content of the ethanol extract of the dried peels was based on the gallic acid standard curve. The total phenolic content of the ethanol extract of the dried peels was 47.82 ± 2.61 GAE/g. Phenol compounds are a large and diverse group of molecules with biological activities, including antioxidant properties [15]. The ability of antioxidants as scavengers of free radicals is associated with the ability of these antioxidants as proton and electron donors. Various phenolic compounds show a high correlation in capturing free radicals with different capacities [16].

3.3. Total Flavonoid Concentration

The results of determining the total levels of Flavonoids in the ethanol extract of the dried peels can be seen in Table 3.

According to table 3, the total level of flavonoids in banana peels' ethanol extract is 10.92 ± 0.54 mg QE/g extract. Flavonoids such as quercetin are known as potential antioxidants. Most flavonoids have antioxidant activity due to the presence of phenolic hydroxyl groups in their molecular structure. When these compounds react with free radicals, they form new radicals that are stabilised by aromatic nuclei's resonance effect [17]. A previous report by [18], found the

phenol content of bananas from two kinds of banana, Cavendish and Dream, were 5.85 and 6.85 mgGAE/g, respectively. In addition, they found the total phenol content of 0.91 and 0.16 mgGAE/g from dried banana peels in two ripeness phases (ripe and green). Differences in total phenolics, flavonoids, and tannins concentration between the present results and those of other researchers can be related to plant species, ambient conditions, and sample preparation. In addition, the changes in phenolic content may be attributable to the fruit component and solvent employed to create the extract.

Table 3 Results of Total Flavonoid Levels in Ethanol Extract of Banana Peel

Weight (g)	Volume (ml)	Absorbance	Concentration (µg/ml)	Concentration (mgQE/g extract)	Concentration Mean (mgQE/g extract)
0.0259	25	0.166	11.74	11.34	10.92 ± 0.54
0.0257	25	0.153	10.59	10.30	
0.0256	25	0.162	11.39	11.12	

4. Conclusion

The characteristics of dried samples met the standards. In addition, the peel extract's total phenol and flavonoid content was 47.82 ± 2.61 GAE/g extract and 10.92 ± 0.54 mg QE/g extract, respectively.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest for this manuscript.

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