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Uncovering Potential Health Beneficial Nutrient of Underutilized Crop Waste: An Insight from Ash and Metal Content Study of Banana Corm

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Abstract

Banana corm is considered unvaluable agricultural waste and is mainly discarded and left unused once the fruits are harvested. Uncovering the hidden values of this waste could be beneficial because of its abundance as a source. Hence, here we study the metal content of banana corm to find its potential health nutrients. The corm from three banana species, *Musa balbisiana* Colla., *Musa x paradisiaca* L. AAA, and *Musa x paradisiaca* L. ABB were collected, prepared, dried, and extracted with ethanol 70%. Dried material and extracts obtained were subjected to total ash and acid insoluble ash determination by gravimetric method and further subjected to metal determination by ICP-EOS tools. The results showed that *M. x paradisiaca* AAA showed the highest ash content among all three banana species in dried materials and extracts with values of 7.64% and 31.06%, respectively. The most abundant metal contained is potassium, with a *M. x paradisiaca* AAA had the highest content of potassium in dried samples with 18.774%. It is concluded that banana corm could be a potential source of potassium, which is beneficial in dietary or as supplementation to increase the daily intake of potassium to improve general health.

Keywords: banana corm, beneficial nutrient, crop waste, metal, potassium

Mengungkap Potensi Nutrisi yang Bermanfaat bagi Kesehatan dari Limbah Tanaman Studi Kandungan Abu dan Logam pada Bonggol Pisang

Abstrak

Bonggol pisang sering dianggap sebagai limbah pertanian yang kurang bernilai, dimana umumnya limbah bonggol dibuang dan tidak digunakan setelah buahnya dipanen. Untuk meningkatkan nilai dari limbah, potensi kandungan nutrisi yang bermanfaat bagi kesehatan perlu digali mengingat melimpahnya ketersediaan limbah bonggol pisang sebagai sumber bahan baku, antara lain sumber logam yang dibutuhkan oleh tubuh. Oleh karena itu, kandungan logam dari bonggol pisang dipelajari untuk mengetahui potensi nutrisi yang memiliki manfaat untuk kesehatan. Bonggol dari tiga spesies pisang, *Musa balbisiana* Colla., *Musa x paradisiaca* L. AAA, dan *Musa x paradisiaca* L. ABB dikumpulkan, disiapkan, dikeringkan, dan diekstraksi dengan etanol 70%. Kadar abu total dan abu tidak larut asam dari simplisia dan ekstrak ditentukan dengan metode gravimetri dan selanjutnya dilakukan penentuan kadar logam menggunakan instrumen ICP-EOS. Hasil penelitian menunjukkan bahwa *M. x paradisiaca* AAA memiliki kadar abu tertinggi di antara ketiga spesies pisang dalam simplisia dan ekstrak dengan nilai masing-masing 7,64% dan 31,06%. Logam yang paling melimpah adalah kalium, dengan *M. x paradisiaca* AAA memiliki kandungan kalium tertinggi pada simplisia dengan 18,774%. Dapat disimpulkan bahwa bonggol pisang dapat menjadi sumber kalium yang potensial, yang dapat dimanfaatkan dalam bentuk makanan atau sebagai suplemen untuk meningkatkan asupan kalium harian guna meningkatkan kesehatan secara umum.

Kata Kunci: Bonggol pisang, limbah tanaman, kalium, logam, nutrisi bermanfaat

1. Introduction

Crop waste generated from agricultural activities is often seen as unvaluable residue materials and ends up burned, dumped, or simply placed in landfill and left unused.[1,2] Some wastes go through a treatment to convert them into useful products, contributing to a circular bioeconomy and becoming a sustainable source for various purposes.[3,4] The medicinal benefit of crop waste or byproducts is one thing that could be the added value, ranging from a source of bioactive compounds to a source of minerals needed for health.[1,5,6]

Banana waste is one of the abundant crop wastes, especially in a tropical country like Indonesia, where almost 60% of the biomass becomes a waste after harvest.[7] The underground stems or corms are among the waste biomass. Our previous study (unpublished data) showed that the banana corm, especially in its extract, has high total ash content. Other studies report of considerably high ash content of all parts of the banana.[8] Ash contains inorganic materials such as phosphates, sulphates, chlorides, and other metals such as sodium, potassium, calcium, manganese, iron, and magnesium[9], indicating the banana corm as a potential source of minerals and metals.

Some metals such as sodium (Na), potassium (K), magnesium (Mg), and calcium (Ca) are currently considered essential for the human body. Sodium and potassium might act as cofactors for several proteins and play an important role for its biological activity.[10]

Other metals that might be contained in crops are heavy metals, which, in a certain amount, would do harm to the human body.[11] Hence, heavy metals content is regulated and should meet the standards set by the National Agency of Drug and Food Control (BPOM), as listed in BPOM regulation No. 32 of 2019 for standard qualifications and quality of traditional medicine raw materials specifically for heavy metal content of lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg).[12] As a result, a further analysis of metals and heavy metal limit determination from banana corm needs to be carried out. Furthermore, it is necessary to compare the characteristics of ash and metal content in several types of bananas to uncover their potential source. Here, we believe this is the first report of metal content in banana corms of *Musa balbisiana* Colla, *Musa x paradisiaca* L. AAA, and *Musa x paradisiaca* L. ABB.

2. Methods

2.1. Plant collection

The banana corms from 3 different species (*Musa balbisiana* Colla., *Musa x paradisiaca* L. AAA, *Musa x paradisiaca* L. ABB were collected from Sumedang Regency, West Java Province, Indonesia (Lat: -6.8249803, Long: 107.9005681). Plant determination was carried out in Herbarium Jatinangoriensis Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran to ensure the identity of plant samples.

2.2. Plant Preparation and Extraction

The samples were washed, sliced, and dried under direct sunlight, and further by the oven at 60°C. Once dried, the materials were then weighed and sorted to eliminate plant parts other than the corm and other impurities. The sample was then ground using a blender to obtain a powdered form. Extraction was carried out by maceration method with 70% ethanol as solvent for 2 x 24 hours with solvent replacement. The macerate was concentrated using rotary evaporator with a temperature of 40°C and a rotation speed of 75 rpm, and was further evaporated on a water bath at a temperature of 60°C to obtain a crude extract of banana corm.[13]

2.3. Total Ash Content Determination

The dried materials and extracts were each weighed at 2 grams. Each sample was put into a crucible and subjected to gradual exposure to a temperature of 800°C ± 25°C. The ash and crucible were then cooled and weighed until the weight was constant. The weight of the ash was calculated against the weight of the test material (% w/w) to obtain the total ash content.[14]

2.4. Acid Insoluble Ash Determination

The determination of acid insoluble ash

content was carried out after determining the total ash content. 25 mL of 2N HCl was added into the ash in the crucible and heated for 5 minutes. The sample in the crucible was filtered using ashless filter paper (Whatmann No. 41). Then the filtered sample along with the filter paper was put back into the crucible and then heated until the weight was constant.[14]

2.5. Heavy Metal and Other Metal Content Determination

The dried banana corm samples were put into a digestion flask and prepared by dry digestion, while the extracted sample was prepared by wet digestion. The samples were then digested using a heavy metal digester for 15 minutes at a temperature of 95°C without drying out and allowed to cool. The samples were filtered using ashless Whatman filter paper no. 41 and the resulting digestion was dissolved in demineralized water. The absorption was observed using the ICP-OES tool to determine heavy metal and other metal contents in the samples.[15]

3. Result

3.1. Plant preparation and extraction

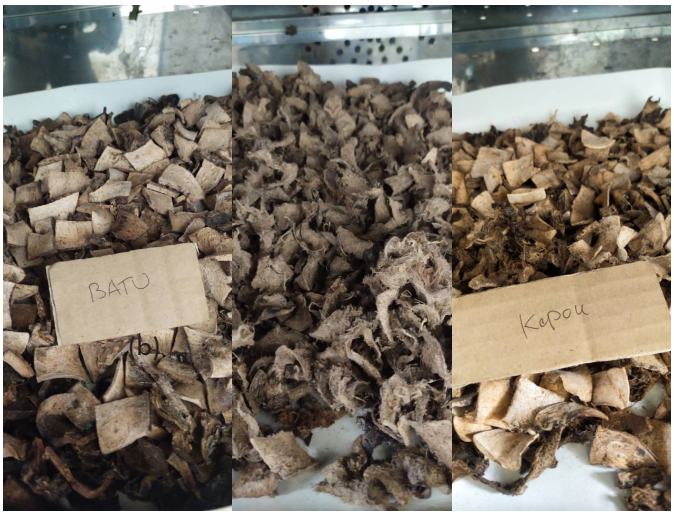
The samples used were *Musa balbisiana* Colla., *Musa x paradisiaca* L. AAA, and *Musa x paradisiaca* L. ABB with the identification number of 183/LBM/IT/IV/2023. The combination of drying method (sunlight and oven) of the fresh corm samples, as shown in Figure 1, resulted in almost similar yields of dried samples as shown in Table 1, with *M. balbisiana* giving a slightly higher yield than the other species. The extraction result showed that *M. balbisiana* also gave a slightly higher yield, followed by *M. x paradisiaca* AAA, and *M. x paradisiaca* ABB, respectively as shown in Table 2.

3.2. Total Ash and Acid Insoluble Ash Content

The total ash and acid insoluble ash content determination from the three bananas showed that *M. x paradisiaca* AAA had the highest total ash in dried material and extract as shown in Table 3.

3.3. Heavy Metal and Other Metal Content

To understand the metal content in the banana corm, a metal analysis was conducted using ICP-EOS tools. The result showed that all heavy metal contents regulated in Indonesia, which is As, Cd, Pb, and Hg, were below the limit value from BPOM as shown in table 4.[12] This indicates a good safety profile of banana corm, despite high acid insoluble ash content, and heavy metals were not the culprit of its high value. The result of heavy metal contents showed the heavy metal content of all samples was below the limit set by Indonesian National Agency of Drug and Food Control (BPOM) is shown in Table 4.



A B C

Figure 1. Dried and sliced banana corm of A.) *M. balbisiana*, B.) *M. x paradisiaca* AAA, C.) *M. x paradisiaca* ABB

Table 1. Result of banana corm drying

Sample	Fresh sample weight (g)	Dry weight (g)	Yield (%)
Musa balbisiana	2700	625	23.15%
Musa x paradisiaca AAA	2300	500	21.74%
Musa x paradisiaca ABB	4200	910	21.67%

Other metal content determination showed that potassium was the highest metal detected from all species of dried banana corms, followed by magnesium and calcium as shown in Table 5. While in extract, potassium was also the most abundant metal followed by magnesium and aluminum, except for *M. x paradisiaca* AAA where calcium was higher than aluminum as shown in Table 6.

4. Discussion

After banana fruit harvest, the rest of the banana plant is considered waste as it bears fruit only once during its lifetime.[16] Hence, the corm is obtained at least after the fruit is harvested and should be available in abundance since bananas are popular crops in Indonesia. The corm was prepared by eliminating the root, peeling the outer part of the corm, washed, and cut into little pieces to make it easier for the drying process. As shown in Figure 1, *M. balbisiana* and *M. x paradisiaca* ABB dried corms showed a similar physical characteristic, while *M. x paradisiaca* AAA was more fibrous in appearance. The yield from the drying process also showed a consistent result with 21-23% dry matter. The dry matter extraction result showed that *M. balbisiana* showed the highest yield with 3.30%, followed by *M. x paradisaca* AAA and *M. x paradisiaca* ABB with 3.23% and 2.50%, respectively. This result is in accordance with a study by Agusta et al. (2021) that obtained equal yield of extraction.[17]

Total ash content determination led to various results. Dried *M. x paradisiaca* AAA had the highest total ash value both in the dried sample and in extract with 7.64% and 31.06%, respectively. *M. x paradisiaca* ABB and *M. balbisiana* gave almost similar results for both dried samples and extracts. From this result, we can see a consistent higher concentration in extracts of all samples indicating that inorganic compounds from the banana corm were well extracted with ethanol 70%. *M. x paradisiaca* AAA also gave the highest value of acid insoluble ash with 0.56% in dry matter and 16.68% in extract. The high number of acid insoluble ash value could be an indication of the presence of higher silica since acid insoluble ash mainly consists of silica.[18] Silica can be obtained from soil, and since corm is an underground stem, it understandably could be contaminated by stubborn dirt or soil even after cleaning or washing with water. Moreover, the fibrous form of sliced *M. x paradisiaca* AAA might trap more dirt or soil compared to other bananas. Nevertheless, this should be a concern on how to optimally clean the dirt or soil when the corm will be used as raw material for traditional medicine or food products to ensure the quality.

Metal content determination revealed that potassium appeared to be the prominent metal content of all banana corms, and was significantly higher than other metals, both in dried samples and in extracts as shown in Tables 5 and 6. *M. x paradisiaca* AAA had the highest content of potassium in dried samples among the other species, followed by *M. x paradisiaca* ABB and *M. balbisiana* with relatively the same content in both species. However, the

Tabel 2. Result of banana corm extraction

Sample	Dried material (g)	Crude extract (g)	Yield (%)
Musa balbisiana	450	14.853	3.30
Musa x paradisiaca AAA	450	14.552	3.23
Musa x paradisiaca ABB	450	11.284	2.50

Table 3. Total ash and acid insoluble content

Sample	Total ash content (%)		Acid insoluble ash content (%)	
	Dried material	Extract	Dried material	Extract
Musa balbisiana	3.57±0,34	13.51±0,17	0.19±0.25	7.59±0.26
Musa x paradisiaca AAA	7.64±0,61	31.06±3,07	0.56±0.35	16.68±0.18
Musa x paradisiaca ABB	4.22±0,04	15.75±0,46	0.62±0.50	0.67±0.20

potassium content of *M. x paradisiaca* AAA in extract was the lowest compared to other species. This could be linked to a higher ash content in the extract compared to others, resulting in a lower concentration of potassium and overall metal compounds compared to *M. x paradisiaca* ABB and *M. balbisiana*. The high content of potassium in all banana corms is understandable, as potassium is greatly extracted by banana plants and directly affects photosynthesis, the translocation of photosythase, and water balance in plants and fruits.[16,17].

From the results obtained, it is shown that banana corms could be a potential source for potassium with its abundance presence in all species tested. Potassium is an essential nutrient in the human body playing a great role, including maintaining fluid balance and osmolarity of cells. Potassium level has a negative association with blood pressure, cardiovascular disease, and kidney disease. Hence, increasing dietary potassium might have a major health impact, as diets worldwide are low in potassium.[18] National Institute of Health in United States of America stated that people in U.S consume less potassium than recommended, and the 2015-2020 dietary guidelines identifies potassium as a public health concern for nutrients.[19] Several studies in Indonesia showed no different results, with the pattern of excessive sodium intake and inadequate potassium consumption.[20–22] Hence, reducing the intake of high sodium dietary, along with increasing intake of potassium might be associated with significant health improvement.

5. Conclusion

Banana corms from all three species contain an abundance content of potassium, followed by a good amount of magnesium both in dried samples and in extracts. *Musa x paradisiaca* AAA showed the highest content of potassium in dried samples with a value of 18.774%, compared to the others. However, the higher ash content in *Musa x paradisiaca* AAA seems to affect the total potassium content in extracts which resulted to be the lowest potassium among the bananas. Banana corms could be a potential source of potassium, which is beneficial in dietary or as supplementation to increase the intake of potassium daily to improve general health.

Table 4. Heavy metal content in dried samples and extracts

Samples	Heavy Metal Content (ppm)			
	As	Cd	Pb	Hg
D *Musa balbisiana*	<0.0001	<0.0001	<0.0001	<0.0001
D *Musa x paradisiaca* AAA	<0.0001	<0.0001	<0.0001	<0.0001
D *Musa x paradisiaca* ABB	<0.0001	<0.0001	<0.0001	<0.0001
E *Musa balbisiana*	0.1858	<0.0001	1.0743	0.1715
E *Musa x paradisiaca* AAA	0.7497	0.0144	<0.0001	<0.0001
E *Musa x paradisiaca* ABB	<0.0001	<0.0001	<0.0001	<0.0001

D: Dried Matter, E: Extract; Limit value: As: ≤5 ppm, Cd: ≤0.3 ppm, Pb: ≤10 ppm, Hg: ≤0.5 ppm[12]

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