

## Studies on the antimicrobial potential of plant extract of banana (Genus *Musa*) in Indonesia

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### Abstract

The positive impact of the discovery of antibiotics coupled with advances in the development of antimicrobial drugs has improved human health. Unfortunately, prolonged use of antibiotics has increased microbial resistance. That is why research to find natural ingredients that have the potential to be developed into plant-derived antimicrobial drugs continues to be carried out throughout the world. Among the plants that have been intensively studied for their antimicrobial properties are bananas of the Genus *Musa* (family Musaceae). In Indonesia, in the last decade there have been quite a lot of studies on the antimicrobial properties of banana plant extracts. Bananas are known to contain a variety of bioactive compounds that are antimicrobial, such as: lycopene, saponins, alkaloids, flavonoids, tannins, phenols, terpenoids, anthocyanins. Microbes that have been proven to be affected with crude extracts of banana plants are fungi such as *Trichophyton rubrum*, *Candida albicans* and *Pityrosporum ovale* and bacteria such as *Enterococcus faecalis*, *Porphyromonas gingivalis*, *Staphylococcus aureus*, *Escherichia coli*, *Lactobacillus plantarum*, *Klebsiella pneumonia*, and *Enterococcus faecalis*. Therefore it can be concluded that banana plants can be used as a source of plant-derived antimicrobial medicine.

**Keywords:** Pisang; Banana; *Musa* spp; Antimicrobial Properties; Anti-Bacterial; Anti-Fungi

### 1. Introduction

Ethnobotanical study revealed that the banana of the Genus *Musa* is a plant that has various benefits. People in the homeland of bananas have been using bananas for generations for various purposes (besides food), such as: food, fodder, medicine, ornamental, wrapping, rope, woven (textile), shelter, raft, and ceremony and religious rituals. In the context of traditional medicine, bananas are used to treat various ailments such as: cuts wound, burns wound, diarrhea, dysentery, internal bleeding, swelling, poisoning, insect bites, and respiratory problems [1,2].

The use of bananas for traditional medicine does not always go through a certain preparation process, some even directly, such as in the treatment of wounds. In certain districts in Indonesia, the wound healing technique is very simple simply apply banana sap to the surface of the injured skin. This technique is still used by the people in the district to this day [3].

In an effort to preserve and develop traditional knowledge about the medicinal benefits of the banana plant, pharmacological studies are being carried out intensively in all banana-producing countries, including Indonesia. The main focus of the research is to determine the pharmacological properties and efficacies of the bioactive content of the plant. Among the pharmacological properties of banana plants that most widely studied are their anti-microbial properties [4].

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The antimicrobial potential of banana plants is enormous because the high diversity of phytochemical content of this plant. As has been revealed from various phytochemical studies, banana plants are rich in bioactive compounds such as: flavonoids, tannins, saponins, anthraquinones, steroids, glycosides, phytosterols, phenols, terpenoids [5].

Bioactive compounds such as polyphenols, phenolics, flavonoids, alkaloids, saponins and terpenoids contained in various types of plants have been shown to have antimicrobial properties. Polyphenolic compounds, for example, are known to be effective antimicrobial against bacteria *Vibrio cholerae*, *Shigelladysenteriae*, *Staphylococcus*, *Salmonella*, *Listeria* and *Lactobacillus* strains. Alkaloid, for the next example, has antimicrobial properties against pathogenic Gram-positive, Gram-negative and acid-fast bacteria and fungi. Saponin as for another instance is known to has antimicrobial against 6 Gram-positive, 12 Gram-negative bacterial species and three *Candida* (fungi) species [6].

In Indonesia, there have been quite a lot of antimicrobial studies of banana plant extracts. Some of the research results that have been scientifically published in the last decade are presented in this paper.

### 1.1. Antimicrobial compounds in bananas

There are many Indonesian researchers who have reported the results of phytochemical screening of banana plant extracts (Genus *Musa*). The types of bioactive compounds detected, types of bananas and plant parts used are presented in Table 1.

**Table 1** Bioactive compounds detected in plant extract of bananas

Bioactives	Banana types	Local name	Plant parts used	References
Lycopene	<i>Musaspp</i>	Pisangmuli	pseudo stem	7
Phenols	<i>Musa balbisiana</i>	Pisangkepok	fruit peel	10
	<i>Musa acuminata</i> var. Jarum	Pisang jarum	fruit	12
	<i>Musa acuminatae</i> , L	Pisang kepok	stalk and corm	13
	<i>Musa paradisiacal</i> var.Sapientum	Pisang ambon	fruitpeel	14
Flavonoids	<i>Musaspp</i>	Pisangmuli	pseudo stem	7
	<i>Musa paradisiaca</i> L	Pisangambon	fruit peel	9
	<i>Musa acuminata</i> (L.)	Pisanggorohomerah	fruit peel	11
	<i>Musa acuminata</i> var. Jarum	Pisang jarum	fruit	12
	<i>Musa acuminatae</i> , L	Pisangkepok	stalk and corm	13
	<i>Musa paradisiacavar</i> .Sapientum	Pisang ambon	fruitpeel	14
	<i>Musa paradisiaca</i> L	Pisang kepok	pseudo stem	15
Saponin	<i>Musa spp</i>	Pisangmuli	pseudo stem	7
	<i>Musa paradisiaca</i> L	Pisang kepok	pseudo stem	8, 15
	<i>Musa paradisiaca</i> L	Pisang ambon	fruit peel	9
	<i>Musa acuminata</i> var. Jarum	Pisangjarum	fruit peel	12
	<i>Musa acuminata</i> L.	Pisang kepok	stalk and corm	13
	<i>Musa paradisciaca</i> var.Sapientum	Pisang ambon	fruitpeel	14
Alkaloid	<i>Musa spp</i>	Pisang muli	pseudo stem	7
	<i>Musa paradisiaca</i> L	Pisangkepok	pseudo stem	8
	<i>Musa paradisiaca</i> L	Pisang ambon	fruit peel	9
	<i>Musa acuminata</i> L.	Pisang oroho merah	fruit peel	11
	<i>Musa acuminata</i> var. Jarum	Pisang jarum	fruitpeel	12

Tannin	<i>Musaspp</i>	Pisang muli	pseudo stem	7
	<i>Musa paradisiaca</i> L	Pisang kepok	pseudo stem	8, 15
	<i>Musa paradisiaca</i> L	Pisang ambon	fruit peel	9
	<i>Musa acuminata</i> L.	Pisang goroho merah	fruit peel	11
	<i>Musa paradisiacavar.Sapientum</i>	Pisang ambon	fruitpeel	14
Terpenoid	<i>Musa acuminata</i> var. Jarum	Pisang jarum	fruit peel	12
	<i>Musa paradisiaca</i> var.Sapientum	Pisang ambon	fruitpeel	14
Anthocyanins	<i>Musa paradisiaca</i> var.Sapientum	Pisang ambon	fruitpeel	16

Based on the data in Table 1 above, there are at least 8 types of bioactive compounds contained in banana plant extracts, namely: lycopene, phenols, saponins, alkaloids, tananins, terpenoids, and anthocyanins which have been tested to have antimicrobial properties. Lycopene extracted from the tomato plant has been shown to be antimicrobial against *Bacillus subtilis*, *Bacillus cereus*, *Bacillus licheniformis* *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella typh* [17, 18]. Phenolic compounds that are already sold in the market are proven to have antimicrobial properties against bacteria *E. coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Staphylococcus epidermidis*, *Staphylococcus aureus* [19, 20]. Saponin extract of *Sorghum bicolor* reported to has anti-bacterial activity against *Escherichia coli* and *Staphylococcus aureus* and antifungal activity against *Candida albicans* [21]. Next, alkaloids diketahui are known to have antimicrobial activity against bacteria and fungi [22]. Tannins, the another bioactive compound, extracted from *Catharanthus roseus*, *Terminalia arjuna* and *Piper betel* known to have antimicrobial activity against both Gram positive and Gram negative bacteria [23]. Next, terpenoids. This compound has been shown to have antimicrobial properties against *Salmonella enterica*, *S. aureus* and *E. coli* [24]. Lastly, anthocyanins. Antimicrobial test of anthocyanins revealed that this bioactive compound showed antibacterial against *Escherichia coli* and *Salmonella* [25].

## 2. Antimicrobial properties of banana plant extract

Studies on the pharmacological benefits of banana that have been conducted in the banana home land countries including Indonesia, revealed that plant extract of banana showed antimicrobial properties both on fungi and bacteria. The research results on antimicrobial tests of several types of bananas that have been carried out in Indonesia in the last 10 years are presented in Table 2.

**Table 2** Plant extract of banana that showed antimicrobial properties

Banana types	Local name	Parts used	Solvent	Microbes affected	References
<i>Musa paradisiaca</i>	Pisang kepok	fruit peel	ethanol	<i>Trichophyton rubrum</i>	26
<i>Musa paradisiaca</i>	Pisang kepok	stems and roots	methanol	<i>Candida albicans</i>	27
<i>Musa x paradisiacal</i> L.	Pisang Agung Semeru	fruit peel	ethanol	<i>Candida albicans</i>	28
<i>Musa acuminata</i>	Pisangm+auli	pseudo stem	ethanol and methanol	<i>Candida albicans</i>	29
<i>Musa balbisiana</i> Colla	Pisang batu	fruit peel	ethanol	<i>Candida albicans</i> , <i>Candida tropicalis</i>	30
<i>Musa paradisiacal</i> Formatypica	Pisang kepok	fruit peel	ethanol	<i>Candida tropicalis</i>	31
<i>Musa acuminata</i> Colla	Pisang barangan	fruit peel	ethanol	<i>Pityrosporum ovale</i>	32
<i>Musa paradisiaca</i> L	Pisang barangan	fruit peel	ethanol	<i>Candida albicans</i>	33

<i>Musa x paradisiacal</i> L.	Pisang Agung Semeru	fruit peel	distilled water	<i>Candida albicans</i>	34
<i>Musa paradisiaca</i>	Pisang	fruit	methanol	<i>Streptococcus sp</i>	35
<i>Musa paradisiaca</i> L	Pisang kapok kuning	fruit peel	ethanol	<i>Enterococcus faecalis</i>	36
<i>Musa paradisiaca</i> L	Pisang kapok kuning	fruit peel	methanol	<i>Porphyromonas gingivalis</i>	37
<i>Musa x paradisiaca</i> L.	Pisangsusu	fruit peel	ethyl acetate	<i>Staphylococcus aureus</i> , <i>Escherichia coli</i>	38
<i>Musa paradisiaca</i> L.	Pisang kepok	bunch stalk	ethanol	<i>Staphylococcus aureus</i>	39
<i>Musa Sp</i>	Pisang	fruit peel	methanol	<i>E. coli</i>	40
<i>Musa balbisiana</i> Colla Bb	Pisang klutuk	fruit flesh and peel	ethanol	<i>Staphylococcus aureus</i> , <i>Escherichia coli</i>	41
<i>Musa paradisiaca</i>	Pisang	corms	ethanol and ethyl acetate	<i>E.coli</i> , <i>S.aureus</i> , <i>S. typhi</i> , <i>B.cereus</i>	42
<i>Musa acuminata</i>	Pisang	blosom	water	<i>Lactobacillus plantarum</i> , <i>Klebsiella pneumonia</i>	43
<i>Musa paradisiaca</i> var. <i>sapientum</i>	Pisang ambon	pseudo stem	water	<i>Enterococcus faecalis</i>	44

Based on the research data on the antimicrobial properties of banana plants in Table 2 above, there are two important things to consider. First, there is a lot of confusion regarding the name of the banana species or cultivar and its local name. The same cultivars are called by different local names, while the same local name is applied to distinct cultivars. Although the nomenclature confusion should not occur in a scientific work, in the case of banana plants the error is understandable. The reason is that in the world, including Indonesia, there are hundreds of varieties and cultivars of bananas which make the classification and nomenclature of bananas a complicated issue [45].

Secondly, research on the pharmacological properties of banana plant extracts in Indonesia (Table 2) mostly still use crude extracts. A common drawback of using crude extracts in pharmacological properties testing of natural products is that it is difficult to ascertain which compound components are effective at a single target. Crude plant extracts are multi component mixtures in which some may be active or inactive at certain targets [46].

In order to make crude extract of plant feasible and suitable for medicine an extract need to be further processed through various techniques of extraction and fractionation to isolate individual chemical entities. To attain the therapeutically desired portions and to eliminate unwanted material, all procedure of extraction and fractionation should be standardized [47].

### 3. Conclusion

Apart from the many technical obstacles faced by researchers, pharmacological studies on the antimicrobial properties of banana plants in Indonesia in the last decade have made a significant contribution. Various species and banana cultivars are known to contain bioactive compounds that have anti-microbial properties, both against bacteria and fungi. Thus it can be concluded that the banana of Genus *Musa* (family *Musaceae*) is a plant that has the potential to be used as a source of plant-derived medicine.

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## Compliance with ethical standards

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### Disclosure of conflict of interest

The authors declare no conflict of interest.

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