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Identification by GC-MS of the Components of Oils of Banana Peels Extract, Phytochemical and Antimicrobial Analyses

[1]R.C. Mordi, [1]A.E. Fadiaro, [1]T.F. Owoeye, [1]I.O. Olanrewaju, [1]G.C. Uzoamaka and [2]S.J. Olorunshola

[1]Department of Chemistry,

[2]Department of Biological Sciences, Covenant University, Canaan Land, Km 10 Idiroko Road, OTA, Ogun State, Nigeria

Corresponding Author: R.C. Mordi, Department of Chemistry, Covenant University, Canaan Land, Km 10 Idiroko Road, OTA, Ogun State, Nigeria

ABSTRACT

Banana is eaten all over the world by all sections of the population. A lectin, called BanLec, was isolated from banana fruit and found to possess anti-HIV-1 activity. However, the peels of banana are thrown away as rubbish although farmers are known to use them as feed for their animals. We thought that there might be some valuable chemicals in banana peels and therefore decided to extract the oils from their peels. Two varieties of Nigeria bananas were chosen for an initial study. The crude methanolic extract was subjected to phytochemical analysis, which revealed the presence of steroids, saponin, terpenoids, anthraquinones and tannins. Antimicrobial study of the methanolic extract showed that the oils were effective against some bacteria. The chemical constituents of the oils were identified and characterized by GC-MS. The fatty acids stearic, palmitic, oleic and linoleic acids and their methyl esters as well as 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one, 5-(hydroxymethyl)-2-furancarboxyaldehyde, cyclododecane, dibutyl phthalate, b-sitosterol, sesamin and epi-sesamin were among the identified components. These constituents were found to be compounds with known biological and medicinal activity.

Key words: Banana peels, *Musa sapientum*, *Musa acuminata* cola, chromatography, mass spectrometry

INTRODUCTION

Many in the developing world countries depend on traditional practitioners for their health care needs. Traditional practitioners in turn depend on plants and herbs for the preparation of medicines for effective treatment of illness.

The banana is a fruit that is available throughout the world. It has been reported that both banana fruit and peel are effective in the treatment of various conditions, from the treatment of simple bruises to reducing the pain in flares of arthritis and even possibly having anticancer properties (Kadan, 1962; Edwards, 1999; Ghani, 2003). Recently, BanLec was isolated from banana, which has been reported to have anti-HIV-1 property and would be of particular interest in the developing world, given the high cost of conventional pharmacological treatment (Swanson *et al*., 2010). Extracts of banana are known to have antioxidant properties as well as antitumor properties (Nagarajaiah and Prakash, 2011). Some of the substances found in bananas have been reported to help activate the cells of the stomach lining, stimulating cell proliferation thereby thickening the

stomach mucosa and acting as barrier against stomach acids while other substances like protease inhibitors help eliminate bacteria in the stomach, which are the primary cause of stomach ulcers (Goel and Sairam, 2002; Agarwal *et al*., 2009; Jain *et al*., 2007). The antibacterial and antimicrobial activities, dyeing performance and effectiveness of banana peels extract have been reported (Shah *et al*., 2012; Fagbemi *et al*., 2009; Ragasa *et al*., 2007).

In most parts of the world where bananas are eaten, the banana peel is simply discarded as rubbish, although in certain areas, it is used as animal feed. Although, banana peel is biodegradable, its disposal causes unsightly pollution. With this environmental concern in mind and some beneficial uses of banana, it was decided to investigate the usefulness of the peel with the aim of extracting and identifying any useful chemicals that may be available in it.

MATERIALS AND METHODS

Two varieties of Nigerian banana (*Musa sapientum* and *Musa acuminata* colla) were obtained. The species were confirmed in the Biological Science Department of Covenant University.

The peels were removed and cut into small pieces. Three hundred gram of the banana peels of each species were exhaustively extracted with methanol as solvent in a Soxhlet extractor. The methanol solvent was removed on a rotary evaporator to afford the crude extract, which was stored away from light for analysis.

Antimicrobial activity of the methanolic extract was performed on the following microorganisms: *Bacillus* spp., *Pseudomonas* spp., *Escherichia* coli, *Staphylococcus aureus*, *Streptococcus* spp., *Klebsiella* spp., *Proteus* spp. and *Salmonella* spp. One gram of the test compound was dissolved in 10 cm^3 of 50% DMSO. The agar well diffusion method was used and the bacteria isolates were standardised with 0.5 M MacFaland standard solution. The isolates were subcultured using nutrient agar and incubated for 24 h at 37°C. 0.3 cm^3 of the DMSO solution was then introduced into the bore hole to test for antimicrobial activity. Gentamicin antibiotic was the standard used for analysis. The activity index was computed by subtracting the diameter of the well from the diameter of the clearing zone divided by the diameter of the well.

The GC-MS analysis was carried out on a GC 7890A (Agilent Technologies) comprising injector (7683B) and gas chromatograph interfaced to mass spectrophotometer (5975C). The injector temperature was kept at 250°C. The oven temperature was programmed from 80°C held for 2 min increased to 120°C at the rate of 5°C min^{-1} and held for 2 min and finally increased to 240°C at the rate of 10°C min^{-1} and held for 6 min. One milliliter of the crude extract dissolved in methanol was injected onto a 30 m 95% polysiloxane HP5MS Agilent Technologies capillary column (thickness 0.25 mm, id 0.320 mm). The carrier gas was helium.

RESULTS AND DISCUSSION

Initial tests of the crude extracts were found to have antimicrobial activity against several bacteria; *Bacillus* spp., *Escherichia coli*, *Pseudomonas* spp., *Klebsiella pneumoniae*, *Staphylococcus aureus* and *Streptococcus* spp. The extracts were not responsive to *Salmonella* spp. Also, the extract from *Musa sapientum* was not responsive to *Proteus vulgaris*. Results of these tests are shown in Table 1. The activity index shows how effective these extracts are against the organisms used, however the extracts are not as effective as the Gentamicin standard.

Phytochemical screening of the extracts shows the presence of anthraquinones, terpenoids, steroids, tannins and trace amounts of phenols (Table 2). Some of these compounds have been reported to be present in peel extracts (Zafar *et al*., 2011).

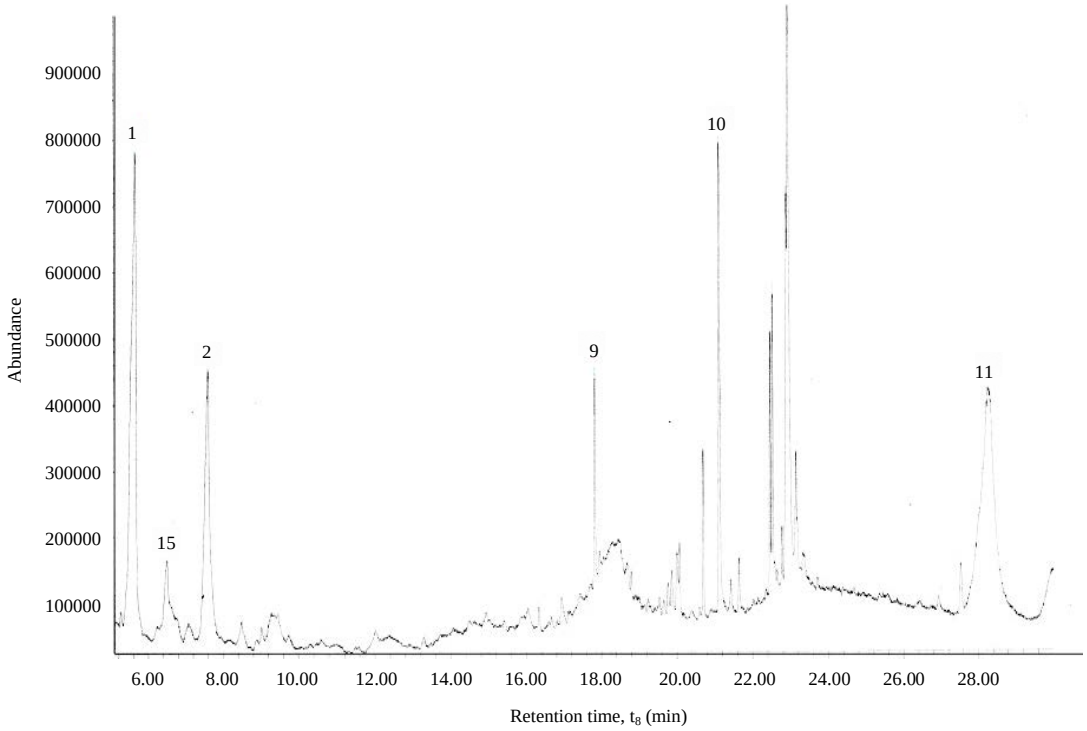

Fig. 1: GC of the components of the methanolic crude extract of *Musa sapientum*

Table 1: Antimicrobial test results of the crude extract

	Clearing zone (mm)				
	Sample size (0.3 cm^3)			Activity index	
Organisms	*Musa acuminata* colla	*Musa sapientum*	Gentamicin standard	*Musa acuminata* colla	*Musa sapientum*
Bacillus spp.	9.00	7.00	26.00	0.65	0.73
Staphylococcus aureus	12.00	7.00	25.00	0.52	0.72
Pseudomonas spp.	10.00	6.00	26.00	0.62	0.77
Escherichia coli	11.00	7.00	22.00	0.50	0.68
Streptococcus spp.	16.00	10.00	22.00	0.27	0.55
Klebsiella spp.	10.00	12.00	22.00	0.55	0.45
Proteus spp.	5.00	R	25.00	0.80	-
Salmonella spp.	R	R	R	-	-

R: Not responsive

Table 2: Phytochemical screening of the crude extract

Phytochemicals	*Musa acuminata* colla	*Musa sapientum*
Saponin	-	-
Anthraquinones	-	++
Terpenoids	++	++
Tannins	++	++
Steroids	++	++
Phenols	Trace	Trace
Flavonoids	-	-

++: Present, -: Absent

The results of the GC-MS analyses of the crude extracts are shown in Fig. 1. Identification of these compounds was confirmed by comparison of the mass spectra obtained with literature mass spectra where available.

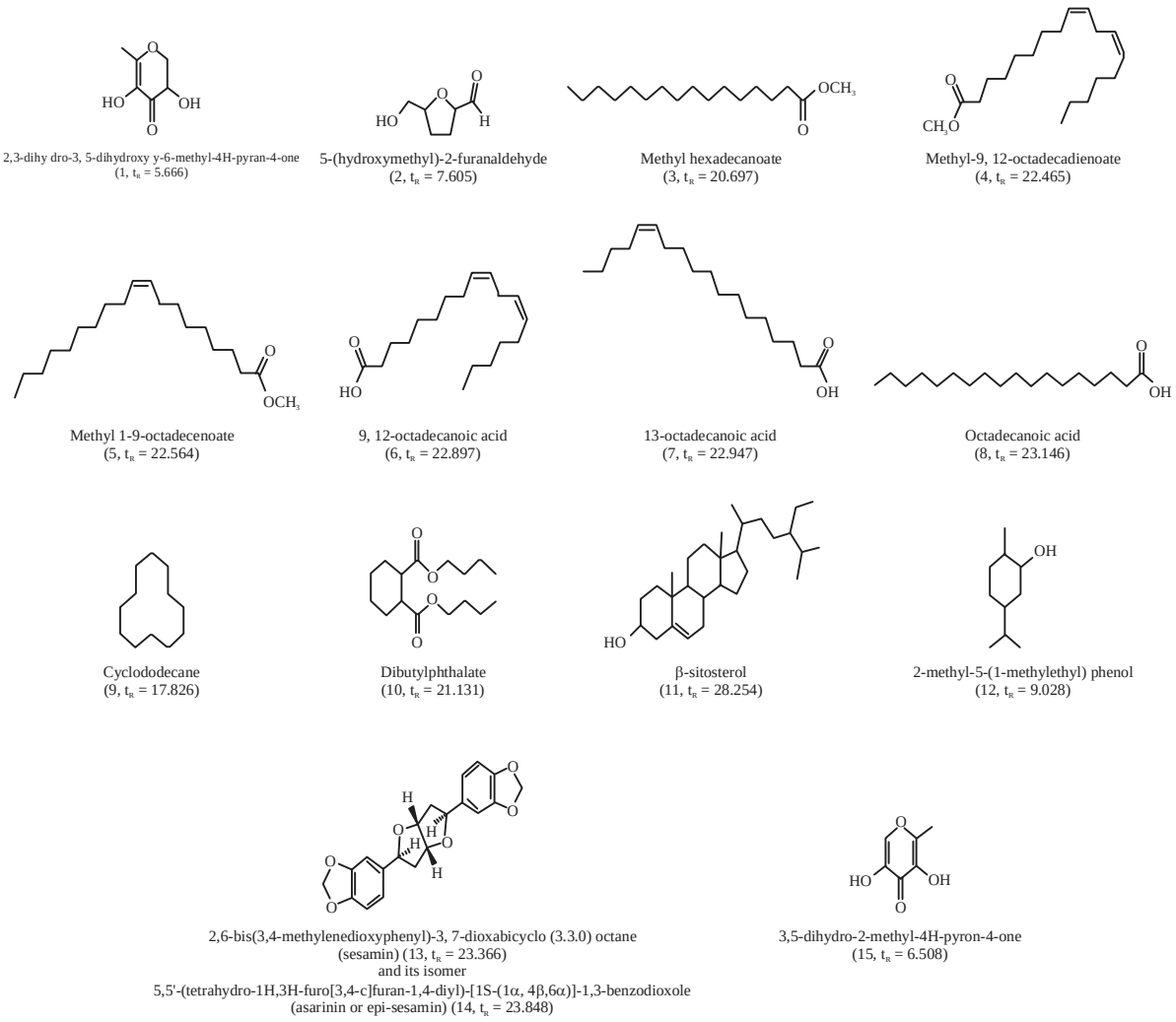

Fig. 2: Structures of compounds identified from the crude methanolic extracts of *Musa sapientum* and *Musa acuminata* colla by GC-MS

In this study, fourteen compounds were identified from the methanol extracts by Gas Chromatography-Mass spectrometry (GC-MS) of the two species of banana. Both species of banana contain some common constituents (compounds 1-8, Fig. 2) whereas, compounds 9, 10 and 11 were only present in *Musa sapientum* and compounds 12, 13 and 14 were present only in *Musa acuminata* colla.

An interesting point in this work is the identification of compounds from the extracts that are known to have some form of biological activity. For example compound 1 which was found in both banana species is known to be a strong antioxidant, possessing anti-microbial, anti-inflammatory and anti-proliferative activity (Dhanalakshmi and Manavalan, 2014), compound 9 is used as an intermediate in the production of flame retardants, detergents and as a volatile binding medium during excavation and transport of archaeological objects (Muros and Hirx, 2004), compound 10 is an additive to adhesive or printing inks, a plasticizer and also used in cosmetics and compound 11 found in *Musa sapientum* is an antihyperlipoproteinemic agent (Windholz, 1983). It is used in

curing heart disease and high cholesterol, for boosting the immune system and preventing colon cancer, gallstones, common cold and flu, HIV/AIDS, rheumatoid arthritis, tuberculosis, migraine, chronic fatigue syndrome etc. and compound 12 found in *Musa acuminata* colla has been shown to inhibit the growth of several bacterial strains leading to its use as an antiseptic, antibacterial and antifungal agent; compounds 13 and 14 also identified in *Musa acuminata* colla have antioxidant property, anticholesteremic and antihypertensive agent and act as an insecticide synergist and have antitubercular activity (Windholz, 1983). Stearic acid, oleic acid, linoleic acid and their methyl esters as well as the methyl ester of palmitic acid were found in both species of banana whereas palmitic acid was found in *Musa acuminata* colla. These fatty acids and their esters have previously been reported as components of banana peels (Hassan *et al*., 2010). It is also interesting to note that the components identified here are completely different from that reported previously by other authors (Waghmare and Kurhade, 2014). The difference in composition of these extracts could be due to the treatment of the peel before extraction. Whereas, in the previous report the banana peel was dried, powdered and extracted with ethanol, we used the fresh peel and extracted with methanol. The difference may also be attributed to the species of banana; even in our own work, we can see that there are differences in the constituents identified from the two varieties studied.

CONCLUSION

These biologically active compounds found in something that is often simply discarded suggests that banana peels may in fact be useful source of medicinal ingredients. The presence of these compounds confirms a potential role for the use of banana peels in pharmaceutical, cosmetics and soap making industries etc. It is concluded that the studied peels can be a potential source of useful antibacterial drugs. This study has shown that there are useful medicinal agents in banana peels which need to be exploited.

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