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Exploring the Biochemical Components of Fresh Peels of Three Varieties of *Musa sapientum* (Banana)

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Abstract: *Musa sapientum*, commonly known as banana is an elongated, edible fruit – botanically a berry produced by several kinds of large herbaceous flowering plants. Banana peels have the potentials to support microbial growth. This research was focused on the fresh peels of three banana species *(Musa acuminata, Musa balbisiana* and *Musa paradisiaca*). Samples were collected from Angalabiri Community in Sagbama Local Government Area of Bayelsa State, Nigeria, and a comparative study of the proximate, mineral and phytochemicals in the fresh peels was carried out. From the mineral analysis result, ash content seems to be higher in *Musa balbisiana*, 1.38%. Protein, fat, fiber and carbohydrate contents (2.09%, 16.40%, 18.38%, and 22.44%) were higher for *Musa paradisiaca* peels indicating that the peels could be a good source of fiber and carbohydrate. Gas chromatography-mass spectrometry (GC-MS) analysis of methanolic extract of the peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca* showed fifteen phytochemicals respectively. Moderate amounts of caryophyllene (56.1% and 28.9%), were identified in *Musa balbisiana* and *Musa paradisiaca* speceies, indicating that the peels of *Musa balbisiana* and *Musa* paradisiaca could be good sources of food additive, typically for flavoring. Significant amount of Humulene, 68.4%, was identified in the peels of *Musa paradisiaca*, also indicating that the peels could be a good source of antibiotics.

Keywords: Explore, Proximate, Mineral, Biochemicals, Banana Peels

1. Introduction

Fruits and vegetables are important components of a healthy diet. They are known to reduce risk of several chronic diseases such as cardiovascular diseases, cancer, Parkinson's disease [1, 2]. Fruits and vegetable peels are major by-products obtained during the processing of various fruits. Peels are good sources of polyphenols and antioxidants, indicating that they can neutralize harmful free radicals that would otherwise damage body cells and increase the risk of conditions like cancer, diabetes, and heart disease [3]. Carotenoids; these richly colored molecules are the sources of the yellow, orange, and red colors of many plants. Fruits and vegetables provide most of the 40 to 50 carotenoids found in the human diet. α-Carotene, β-carotene, β-cryptoxanthin, lutein, zeaxanthin, and lycopene are the most common dietary carotenoids [3]. Carotenoids play important functions as pro-vitamin A, antioxidants and immunoregulators. They also have a critical role in the photosynthetic process and carry out a protective function against damage by light and oxygen [4].

Musa sapientum, commonly known as banana is an elongated, edible fruit – botanically a berry produced by several kinds of large herbaceous flowering plants [5]. The world main producers of banana are India, China, Uganda, Ecuador, Philipines and Nigeria [6]. Musa species is a major staple crop of considerable importance in the developing world. They are consumed as energy giving food and as dessert. Unlike most plantain, banana is usually eaten without further preparation [7]. The peel colour is often the major post-harvest criterion used by researchers, growers and consumers to determine whether the fruit is ripe or unripe [8]. *Musa sapientum* fruits have been reported to prevent anaemia by stimulating the production of haemoglobin in the blood. Its role to regulate blood pressure has been associated with the high content of potassium [9]. Recent finding shows that banana peel is an organic waste that is highly

rich in carbohydrate and other basic nutrients that could potentially support microbial growth. Komal *et al.* [10]. Kandasamy and Aradhya [11] have shown the banana rhizome to be a rich source of many polyphenolic compounds having antioxidant activities. Pazmino-Duran and others [12, 13] have suggested the use of anthocyanins from banana bracts (florets) as natural colourants. Flavonoid and leucocyanidin. The phytochemistry and pharmacology of wild banana (*Musa acuminata* Colla) have been reviewed by Mathew an others [14], they suggested the use of banana pulp and peel for the development of drugs and use in functional foods.

Aziz and others have analysed the native banana pseudo-stem flour (NBPF) and tender core of pseudo-stem flour (TCBPF) for chemical and functional properties [15]. They found higher content of polyphenols, flavonoids, total dietary fibre, insoluble dietary fibre, lignin, hemicellulose, cellulose, antioxidant capacity, and free-radical scavenging capacity in NBPF than TCBPF. Anyasi *et al.* [16] have analysed essential macro and trace minerals as well as phenolic compounds in unripe banana flour obtained from the pulp of four cultivars treated with ascorbic, citric, and lactic acids before drying in a forced air dryer at 70°C. Results of their liquid chromatography-mass spectrometry-electrospray ionization (LC-MS-ESI) assay revealed the presence of two flavonoids, epicatechin and 3-O-rhmnosyl-glucoside in varying concentrations. Carotenoids present in banana fruit, α-carotene, β-carotene, and β-cryptoxanthin have provitamin A activity while lycopene and lutein have a strong antioxidant capacity [17]. Yellow- and orange-fleshed banana cultivars are known to be richer in trans-β-carotene content [18]. Banana peel and pulp both are good sources of health-promoting phenolic compounds [19-21].

Although, different studies on the pulp of different banana species are reported in the literature, this study is to explore and compare the biochemical components of ripe peels of three banana species – *Musa Acuminata*, *Musa Balbisiana* and *Musa Paradisiaca.*

2. Materials and Methods

2.1. Materials

All chemicals used were of analytical grades and obtained from BDH, Labtech chemicals, Ken Light Laboratories, Kermel.

2.2. Methods

Freshly harvested banana fruits were gotten from a farm in Angalabiri Community in Sagbama Local Government Area, Bayelsa state, Nigeria, and properly identified at the Department of Biochemistry, University of Africa, Toru-Orua, Bayelsa State, Nigeria. The samples were washed, drained and the peels manually removed from the pulp, cut into pieces and pulverized using electronic blender and kept safe in a desiccator for analysis.

2.2.1. Proximate Analysis

Standard procedures as described by the Association of Official Analytical Chemists [22] were employed in the determination of moisture, Fat, Ash, Crude fibre, Crude Protein and Carbohydrate Content.

2.2.2. Mineral Analysis

Standard procedures as described by the Association of Official Analytical Chemists [22] were used to determine Manganese (Mn), Iron (Fe), Calcium (Ca), Phosphorus (P) and Potassium (K).

2.2.3. Phytohemicals

GC-MS analysis of methanol extract of the peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca* was carried out with GC (Agilent 6890) and MS (5973 MSD) equipped with Restek capillary column (30 m × 0.53mm; film thickness 0.12μm), using Helium as the carrier gas with a flow rate of 1 mL/min.

3. Results and Discussion

Results of the various analyses carried out on the peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca* are presented as follows:

Table 1. *Proximate analysis of fresh banana peels per 100 grams.*

Proximate	Variety / Species	Composition of wet sample (%)
Moisture%	*Musa acuminate*	86.00 ± 0.01
	Musa balbisiana	80.04 ± 0.02
	Musa paradisiaca	85.28 ± 0.01
Ash%	*Musa acuminate*	0.74± 0.02
	Musa balbisiana	1.38± 0.01
	Musa paradisiaca	0.29± 0.02
Protein%	*Musa acuminate*	1.93± 0.01
	Musa balbisiana	1.19± 0.02
	Musa paradisiaca	2.09± 0.01
Fat%	*Musa acuminate*	6.04± 0.01
	Musa balbisiana	7.04± 0.01
	Musa paradisiaca	16.40± 0.01
Fiber%	*Musa acuminate*	6.14 ± 0.02
	Musa balbisiana	9.71± 0.01
	Musa paradisiaca	18.38± 0.01
Carbohydrate %	*Musa acuminate*	0.85± 0.01
	Musa balbisiana	0.64± 0.01
	Musa paradisiaca	22.44± 0.01

Table 2. *Mineral analysis of fresh banana peels per 100 grams.*

Mineral Composition (%)	Variety / Species	Composition of wet sample (%)
Potassium (K)	*Musa acuminate*	0.881± 0.01
	Musa balbisiana	0.343± 0.02
	Musa paradisiaca	1.077± 0.02
Iron (Fe)	*Musa acuminate*	0.001± 0.01
	Musa balbisiana	0.001± 0.01
	Musa paradisiaca	0.004± 0.01
Manganese (Mn)	*Musa acuminate*	0.001± 0.02
	Musa balbisiana	0.002± 0.01
	Musa paradisiaca	0.002± 0.02
Calcium (Ca)	*Musa acuminate*	0.027± 0.01
	Musa balbisiana	0.005± 0.01
	Musa paradisiaca	0.052± 0.01
Phosphorus (P)	*Musa acuminate*	0.183± 0.01
	Musa balbisiana	0.118± 0.02
	Musa paradisiaca	0.234± 0.03

Table 3. *Result of phytochemical analysis on the peels of Musa acuminata.*

S/N	Retention Time	Name of compound	Molecular Formular	Molecular Weight	Peak Area%
1.	6.983	Fluoranthene	$C_{16}H_{10}$	202	80.5
2.	7.017	Pyrene	$C_{16}H_{10}$	202	81.8
3.	9.406	Tetracosane	$C_{24}H_{50}$	338	65.0
4.	10.652	1,1,1,5,7,7,7-Heptamethyl-3,3,5-tris(trimethylsiloxy)tetrasiloxane	$C_{16}H_{48}O_6Si_7$	532	98.9
5.	11.138	Pentacosane	$C_{25}H_{52}$	352	87.7
6.	12.818	Hexanedioic acid, bis(1,3-dimethylbutyl) ester	$C_{18}H_{34}O_4$	314	75.3
7.	13.778	Hexacosane	$C_{26}H_{54}$	366	80.5
8.	14.596	9-Octadecenamide, (Z)-	$C_{18}H_{35}NO$	281	97.7
9.	15.018	Hexasiloxane, tetradecamethyl	$C_{14}H_{42}O_5Si_6$	458	97.9
10.	16.384	Nonacosane	$C_{29}H_60$	408	67.8
11.	16.584	Bis(2-ethylhexyl) phthalate	$C_{24}H_{38}O_4$	390	77.4
12.	17.310	Diisooctyl phthalate	$C_{24}H_{38}O_4$	390	16.0
13.	18.088	Chrysene	$C_{18}H_{12}$	228	87.2
14.	18.333	Naphthacene	$C_{18}H_{12}$	228	6.72
15.	18.882	Octacosane	$C_{28}H_{58}$	394	70.7

Table 4. *Result of phytochemical analysis on the peels of Musa balbisiana.*

S/N	Retention Time	Name of compound	Molecular Formular	Molecular Weight	Peak Area%
1.	1.547	Silane, difluorodimethyl	$C_2H_6F_2Si$	96	93.7
2.	1.902	Methylene chloride	CH_2Cl_2	84	98.9
3.	2.165	Hydrazinecarbothioamide	CH_5N_3S	91	98.2
4.	4.102	Benzene, 1,2-dichloro	$C_6H_4Cl_2$	146	73.4
5.	4.388	Phenol	C_6H_6O	94	83.3
6.	6.103	Nonacos-1-ene	$C_{29}H_{58}$	406	43.0
7.	7.000	Caryophyllene	$C_{15}H_{24}$	204	56.1
8.	7.309	Humulene	$C_{15}H_{24}$	204	87.7
9.	7.611	(3S,3aS,8aR)-6,8a-Dimethyl-3-(prop-1-en-2-yl)-1,2,3,3a,4,5,8,8a-octahydroazulene	$C_{15}H_{24}$	204	67.2
10.	7.749	1-Octadecene	$C_{18}H_{36}$	252	36.4
11.	9.537	Ethyl 2-(2-chloroacetamido)-2-(2,4-difluoroanilino)-3,3,3-trifluoropropionate	$C_{13}H_{12}ClF_5N_2O_3$	374	98.0
12.	11.035	2,4-Cyclohexadien-1-one, 2,3,4,5,6,6-hexaphenyl	$C_{42}H_{30}O$	550	93.2
13.	11.309	1,2-Benzenediol, 3,5-bis(1,1-dimethylethyl)-	$C_{14}H_{22}O_2$	222	90.6
14.	12.167	1,2-Benzenediol, 3,5-bis(1,1-dimethylethyl)-	$C_{14}H_{22}O_2$	222	90.6
15.	12.281	2-(Acetoxymethyl)-3-(methoxycarbonyl)biphenylene	$C_{17}H_{14}O_4$	282	92.9

Table 5. *Result of Phytochemical analysis on the peels of Musa paradisiaca.*

S/N	Retention Time	Name of compound	Molecular Formular	Molecular Weight	Peak Area%
1.	0.702	Z-(13,14-Epoxy)tetradec-11-en-1-ol acetate	$C_{16}H_{28}O_3$	268	12.1
2.	1.896	psi.,.psi.-Carotene, 3,4-didehydro-1,2-dihydro-1-methoxy	$C_{41}H_{58}O$	566	20.8
3.	4.131	N-(1-Hydroxy-4-oxo-1-phenylperhydroquinolizin-3-yl)carbamic acid, benzyl ester	$C_{23}H_{26}N_2O_4$	394	13.0
4.	4.439	Caryophyllene	$C_{15}H_{24}$	204	28.9
5.	6.246	Humulene	$C_{15}H_{24}$	204	68.4
6.	7.143	1,4,7,-Cycloundecatriene, 1,5,9,9-tetramethyl-, Z,Z,Z	$C_{15}H_{24}$	204	16.9
7.	7.440	β-Acorenol	$C_{15}H_{26}O$	222	10.1
8.	7.726	2-Hexadecanol	$C_{16}H_{34}O$	242	17.0
9.	7.857	1-Hexadecanol, 2-methyl	$C_{17}H_{36}O$	256	13.3
10.	8.572	Oxiranedodecanoic acid, 3-octyl-, cis	$C_{22}H_{42}O_3$	354	11.0
11.	9.589	(5β)Pregnane-3,20β-diol, 14α,18α-[4-methyl-3-oxo-(1-oxa-4-azabutane-1,4-diyl)]-, diacetate	$C_{28}H_{43}NO_6$	489	10.5
12.	11.338	Spirost-8-en-11-one, 3-hydroxy-, (3β,5α,14β,20β,22β,25R)-	$C_{27}H_{40}O_4$	428	25.5
13.	12.304	Propanoic acid, 2-(3-acetoxy-4,4,14-trimethylandrost-8-en-17-yl)-	$C_{27}H_{42}O_4$	430	11.2
14.	12.967	Olean-12-ene-3,15,16,21,22,28-hexol, (3β,15α,16α,21β,22α)-	$C_{30}H_{50}O_6$	506	47.9
15.	13.081	Hexadecanoic acid, 1a,2,5,5a,6,9,10,10a-octahydro-5,5a-dihydroxy-4-(hydroxymethyl)-1,1,7,9-tetramethyl-1	$C_{36}H_{58}O_6$	586	10.7

Table 1 summarizes the results of proximate principles of three varieties of fresh banana peels - *Musa acuminata, Musa*

balbisiana and *Musa paradisiaca*. The content of moisture was lower for *Musa balbisiana*, 80.04%. Lower moisture value signifies longer shelf life without mold growth [23] The ash content is higher in *Musa balbisiana*, 1.38% indicating that *Musa balbisiana* contains more inorganic residue [24] Protein, fat, fiber and carbohydrate contents (2.09%, 16.40%, 18.38%, and 22.44%) were higher for *Musa paradisiaca* peels. These values indicate that *Musa paradisiaca* peels could be a good source of fiber and carbohydrate.

Table 2 presents the mineral content of fresh peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca.* Mineral contents of the three varieties of fresh banana peels were inconsequential. Potassium (K) concentration in the peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca* were 0.881%, 0.881% 1.077% respectively. These concentrations were higher than the concentration reported [25]. Iron (Fe) concentration in the peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca* were 0.001%, 0.001% and 0.004% respectively. Higher concentrations were reported in the literature [25]. Trace element, Mn in the peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca* were 0.001%, 0.002% and 0.002% respectively. These concentrations were higher compared to report in the literature [25]. The concentrations of Ca in the peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca* were 0.027%, 005% and 0.052% respectively. Calcium is a mineral most often associated with healthy bones and teeth, it also plays an important role in blood clotting, helping muscles to contract, and regulating normal heart rhythms and nerve functions [26], although the peels of contain no significant amount of calcium. The concentration of P in the peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca* were 0.183%, 0.118% and 0.234% respectively. The present study indicates that fresh peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca* are not rich in minerals but contain significant amount of fibre and carbohydrates.

The result of analysis of the Gas chromatography-Mass spectrometry (GC-MS) of the methanol extract of fresh peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca* with their retention time, molecular weight, molecular formula and peak area percentage are presented in Tables 3 – 5. Fifteen phytochemicals were identified for *Musa acuminata, Musa balbisiana* and *Musa paradisiaca* respectively. Comparatively, the identified compounds in the three banana varieties were different. Phytochemicals identified in fresh peels of *Musa acuminata* include: Fluoranthene, 80.5%, 1,1,1,5,7,7,7-Heptamethyl-3,3,5-tris(trimethylsiloxy)tetrasiloxane, 98.9%, Hexasiloxane, tetradecamethyl, 97.9%, Bis(2-ethylhexyl) phthalate, 77.4% and Chrysene, 87.2%. Hydrazinecarbothioamide, 98.2%, Phenol, 83.3%, Caryophyllene, 56.1%, Humulene, 87.7% and Ethyl 2-(2-chloroacetamido)-2-(2,4-difluoroanilino)-3,3,3-trifluoropropionate, 98.0% were identified in the fresh peels of *Musa balbisiana*. Psi.,.psi.-Carotene, 3,4-didehydro-1,2-dihydro-1-methoxy, 20.8%, Caryophyllene, 28.9%, Humulene, 68.4%, Spirost-8-en-11-one, 3-hydroxy-, (3β,5α,14β,20β,22β,25R)-, 25.5% and Olean-12-ene-3,15,16,21,22,28-hexol, (3β,15α,16α,21β,22α)-, 47.9% were identified in *Musa paradisiaca*. The phyotochemicals whose peak area percentages were less than 5% were considered to be insignificant. *Musa balbisiana* and *Musa paradisiaca* contain Caryophyllene (56.1% and 28.9%). Caryophyllene contributes to the sweet smell of the peels. It is a chemical used as a food additive, typically for flavoring [26]. Significant amount of Humulene in *Musa paradisiaca* indicates that the peels of *Musa paradisiaca* have antibacterial properties against harmful bacteria [27].

4. Conclusion

This research explored and compared the biochemicals of three fresh banana peels - *Musa acuminata*, *Musa balbisiana* and *Musa paradisiaca*. Mineral contents were inconsequential for the three varieties. Proximate - protein, fat, fiber and carbohydrate contents were higher for *Musa paradisiaca* peels, indicating that *Musa paradisiaca* peels could be a good source of fiber and carbohydrate. Gas chromatography-mass spectrometry (GC-MS) analysis of methanolic extract of the peels of *Musa acuminata*, *Musa balbisiana* and *Musa paradisiaca* showed fifteen phytochemicals respectively. Confidently, this research will provide useful biochemical information on the fresh peels of *Musa acuminata, Musa balbisiana* and *Musa paradisiaca*.

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