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THE POTENTIAL EFFECT OF PEEL EXTRACTS OF BANANA VARIETIES: AN IN-VITRO ASSESSMENT

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ABSTRACT
Background: Assamese cuisine is known for its use of kolakhar, a traditional ingredient; Rhizome, the skin and stem of bananas, can be used to make it. An ash filter from a banana tree is used to produce antacids. The word: kol" or "kola" is a local term for banana. In Assam, India, kolakhar is a common food additive and traditional ingredient. **Method:** Water is filtered through banana tree ashes to create this. The banana peel is burned after it has been dried. The ash is subsequently blended with water and left overnight. The mixture is filtered through a fine cloth once the ash has settled to the bottom of the container by the following morning. Several studies were carried out by evaluating the preparation of peel extract, Physicochemical parameters, antioxidant activity, etc. followed by some analytical methods to find the biologically active components, potential uses, and additional benefits of banana peels beyond what they currently serve as waste products. Finally, an antimicrobial study was performed by using the disc diffusion method. In this study, 4 different types of banana species investigated sought to determine the antioxidant capacity, antimicrobial activity, FT-IR, and UV to determine which one is better. **Result:** The physicochemical parameters, analytical technique, and assay provide an overview of the chemical characteristics, phytoconstituents, and food safety of kolakhar, which contribute to its unique properties in both traditional medicine and culinary applications. **Conclusion:** In conclusion, depending on the banana type used, banana peel extracts exhibit considerable promise as organic antioxidants and antibacterial agents. Therefore, considering all parameters, we obtained various potential effects from this study. The results are discussed with a graphical representation of the banana peel extract.

INTRODUCTION

Traditionally, natural therapies have been successfully deployed across the world to provide relief from a range of illnesses. Natural remedies are in high demand for the treatment and prevention of complicated illnesses like cancer, diabetes, stroke, atherosclerosis, & Alzheimer's disease. Indigenous knowledge, passed down through the generations in numerous regions of the world, significantly impacts the improvement of conventional

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healthcare approaches and helps with the scientific validation of traditional usage of medicinal plants through exploration [1]. Globally, a great deal of pharmacological and phytochemical investigation has been done. The world's oldest cultivated crop, the banana, is a well-known tropical fruit that evolved in the Southwestern Pacific and finally made its way to India circa 600 BC. It had spread its journey to the West Coast of Africa and the Pacific Islands by 200–300 BC. Different communities in India have their traditional food dishes. In Assam, however, a traditional food additive called Kolakhar (KK) is used. Kolakhar is made from the ashes of *Musa balbisiana*, a banana species locally called Athiya kol. The preparation usually uses rhizomes and stem peels. Kolakhar, made from Athiya kol, is typically reddish and denser than that made from other banana species, and it is believed to be more effective. A plant belonging to the Musaceae family, Musa, produces bananas as their fruit. These plants are grown mostly for food, but they are also grown for their decorative qualities and as a source of fiber for the textile industry. The two naturally occurring Musa acuminata and Musa balbisiana produce almost all of the edible parthenocarpic bananas consumed. Depending on their genetic makeup, bananas are known by the scientific names Musa acuminata, Musa balbisiana, or hybrids of the two species. Studies on folklore have demonstrated the great therapeutic potential of Musa balbisiana Colla. Numerous studies have been conducted on the diverse therapeutic properties of different Musa spp. It has been demonstrated that in rats given STZ, M. sapientum L. (Family: Musaceae) fruits improve peripheral glucose consumption and cause pancreatic β-cells to secrete more insulin [2].

According to folklore research, Musa balbisiana's root extract (RE), shoot extract (SE), and inflorescence extract (IE) have strong therapeutic qualities; the root extract is used to cure diabetes. Nevertheless, there have only been a meager 9 scientific investigations done thus far concerning the scientific verification of this conventional assertion. Due to the diverse medicine, consuming too many of these food ingredients might harm tissue. Therefore, albino mice were given this alkaline formulation in vivo at a daily dosage of 15 ml/kg body weight. Oral administration was carried out in two animal groups for varying lengths: 20 and 40 days. After the trial, the experimental mice were slaughtered, and their liver and intestines were removed for pathological examinations. The findings demonstrated that liver tissue had varying rates of cellular deterioration. Neutrophils infiltrating the liver tissue is a sign of cellular necrosis [3]. Effects after a long-term (40 days) therapy are documented for intestinal epithelial cells. In some parts of the gut, the surface cell layer collapses. It should be remembered that the extract's effects could vary depending on the dose and length of time. It is impossible to overlook the beneficial effects of this dietary additive, which has been used for millennia in civilization. Consuming specific amounts of extract may help rectify irregular eating patterns and shield the body against metabolic disorders [4]. According to Laeliocattleya et al., ethyl acetate and ethanol were used in an ultrasonic bath to extract powdered candi banana (Musa paradisiaca). It was concluded that ethanol extract has a higher antioxidant activity than ethyl acetate based on the results, which showed that the antioxidant activity (IC50−50%inhibitory concentration) of ethanol extract and ethyl acetate were 3374.13 ± 123.46 and 40318.19 ± 1014.90 ppm, respectively [5]. The unripe Cavendish (*Musa acuminata L*) and Dream banana (*Musa acuminata colla*. AAA cv Berangan) peels exhibited good radical scavenging capabilities in ethanol extracts by Nadirah et al. The IC50 values for the Cavendish and Dream banana were 90.28 μg/mL and 113.09 μg/mL, respectively. The researchers have linked the abundance of phenols, flavonoids, and tannins in the peel extracts to this impact. Thus, the peel's antioxidant contents, such as flavonoids and phenols, suppress DPPH radicals [6]. Peels from Musa species have been shown to have strong in vitro antioxidant activity. The peels of Musa sapientum, Musa paradisiaca, Musa cavendish, and Musa acuminata were subjected to an in vitro antioxidant investigation utilizing the ferric reducing power assay, hydrogen peroxide (H_2O_2) radical scavenging assay, and 2,2-diphenyl-1- picrylhydrazyl radical (DPPH). According to the findings, Musa acuminata has the most significant antioxidant activity against DPPH radicals, followed by Musa cavendish. In the H_2O_2 scavenging and ferric-reducing power assays, Musa acuminata exhibited the highest level of antioxidant activity compared to other extracts. Therefore, considering its possible antioxidant qualities, it would be advantageous to consume the peel of banana fruit [7]. Pooja and colleagues assessed the in vitro antidiabetic potential of methanol extracts derived from three fruit peel types: banana, pomegranate, and lemon. The findings indicated the banana peel had the highest alpha-amylase inhibitory activity (80.87% at 1000 μg/mL). Banana peel has the most hypoglycemic impact out of the three, making it more powerful. Because of this, it is more suitable for use as an antidiabetic supplement than the

others [8]. Ahmed and associates detailed how the antibacterial qualities of banana peel ethanol and acetone extracts were assessed using the well diffusion experiment against various microbiological species. *Bacillus subtilis* (20.60%), *Staphylococcus aureus* (19.75 mm), *Escherichia coli* (18.15 mm), and *Pseudomonas aeruginosa* (19.57 mm) were among the Gram-positive bacteria that 80% acetone extract killed at 600 ppm. This antibacterial characteristic is thought to be related to the presence of phytochemicals, such as tannins and phenolic compounds [9]. An investigation with rats found that the ash from the peel of *Musa sapientum* increased urine volume, K^+ excretion, and other electrolyte excretion compared to normal saline. Banana peel ash may have strong antacid properties based on the diuretic impact that successive ethanolic extract likewise exhibits [10]. Banana peel has wound-healing properties due to its main effects on the mucosal defense factor, which increases DNA synthesis and encourages the proliferation of mucosal cells. Rats were used in an experiment to test the ability of methanol and aqueous extracts of plantain banana (M. sapientum var. paradisiaca) to heal wounds. In addition to increasing wound tensile strength, both extracts were shown to raise levels of hydroxyproline, hexuronic acid, hexosamine, and superoxide dismutase. The extracts also reduced the lipid peroxidation and the regions of wounds and scars. These results were linked to the plantain's antioxidant capacity [11]. The mutagenic impact of M. paradisiaca fruit peel extract in mice was documented by Jain et al. using micronucleus tests and single-cell gel electrophoresis (SCGE). Peripheral blood leukocytes at 1500 and 2000 mg/kg body weight showed DNA-damaging properties in the studies [12].

Banana peels, frequently thrown away as waste, have several bioactive substances that may have major health advantages. Nevertheless, little study has examined the precise effects of banana peel extracts, especially when using in vitro tests. Restricted Research on Particular Varieties Banana peel extracts, or a particular kind of banana, is the subject of most current studies. In vitro Data Although studies on banana peel extracts' anti-inflammatory, antibacterial, and antioxidant qualities have been done, they either lacked rigorous in vitro experimental designs or did not evaluate the benefits across banana kinds [13]. Active Biomolecules Different kinds of banana peels lack comprehensive characterization of the particular bioactive chemicals that may confer health benefits. Studies rarely explore how these chemicals vary depending on the type of banana and how that variation can impact biological functions [14]. The following hypothesis can be developed in light of the found research gaps:

Assumption: Different banana cultivars' peel extracts show differing degrees of bioactivity in vitro, with notable variations in their anti-inflammatory, antibacterial, and antioxidant capabilities. The variance in the concentration and makeup of bioactive chemicals in the peels of various banana cultivars is the cause of these discrepancies." The Reason behind Variety-Specific Bioactivity The bioactive chemical profiles of various banana types may differ regarding polyphenols, flavonoids, and tannins. If biological activity is measured in vitro, these variations may result in different activity levels. Compound Difference Banana peels may provide different health advantages depending on the type and concentration of bioactive chemicals present. For example, one kind might have more antioxidant molecules than another, leading to better antioxidant activity in vitro [15]. Mechanical Understanding Examining the processes by which these extracts work can open our eyes to new uses and assist in choosing the best types of extract for certain medical purposes. Research Directions Suggestions Analysis of Comparatists to assess banana peel extracts' antioxidant, antibacterial, and anti-inflammatory qualities and compare them in vitro using different banana cultivars. Composite Profiling Conduct comprehensive chemical investigations to identify and measure bioactive substances present in the peels of several banana cultivars. Mechanistic Research Examine the cellular and molecular processes that banana peel extracts use to achieve their effects, paying particular attention to how the various kinds affect these processes. Application Potential Evaluate how well the most efficient extracts can be used to create functional foods or health supplements. By filling in these study gaps, we can improve our knowledge of the possible health advantages of banana peel extracts and gain important insights into their prospective uses [16].

METHODOLOGY

Collection and Authentication of Plant Material

An essential step in botanical investigation is collecting and confirming plant samples to validate the precision of scientific results. Environmental and geographic information is required during field gathering to preserve specimen features meticulously. Various techniques are utilized for authentication and confirming species identification compared to established references, such as morphological, anatomical, and genetic

investigations. Conservation efforts and the discovery of therapeutic qualities are the additional supporting taxonomy, guaranteeing the integrity of botanical investigations. Precise recording conserves. Biodiversity knowledge is vital to science and governance of the environment. Musa balbisiana colla, Musa champa baker, Musa paradisiaca and Musa splendida are the members of the Musaceae family. The following plants were gathered from Chandrapur, Guwahati, and Assam in December and January: Musa balbisiana Colla, Musa champa baker, Musa paradisiaca, and Musa splendida. After the plant parts were thoroughly washed under running water and cleared of unnecessary things, the plant's height, color, and soil conditions were recorded in the notebook and other pertinent field data. Guwahati University's Department of Botany helped ensure authenticity. Following its removal, the peal was left to dry in the sun for 30 days. After being reduced to ashes, the dried peel was stored in an airtight glass jar for further study.

Preparation of peel extracts

After shade dried for approximately a week, the pees of fresh, naturally ripened, yellow, unpigmented bananas were ground into a coarse powder. Ethanol was used at a 10 % concentration for solvent extraction after the dry powder was weighed. An exhaustive extraction was performed in a shaker set at 37°C and with gentle shaking for 36 hours. Next, at room temperature, to perform radical scavenging experiments, the leftovers were cleaned by re-evaporating them and storing them at 4°C. Desiccators retained the leftover residue for later use [17].

Phytochemical Analysis

After undergoing the multiple extraction process, the extract was subjected to a wide variety of qualitative tests to determine the content of various phytoconstituents, including, but not limited to, alkaloids, glycosides, saponin, flavonoids, carbohydrates, amino acids, sterols, GM, and mucilage.

Detection of alkaloids

50mg of solvent-free extract is combined with a few milliliters of diluted HCL, stirred, and filtered to identify alkaloids. The filtrate is carefully analyzed using the reagents given below:

Mayer's Test: Add a few milliliters of filtrate and a drop or two of Mayer's reagent to the test tube. A white or creamy precipitate indicates a positive test result.

Wagner's test: A few ml of filtrate and a few drops of Wagner's reagent (Iodine-potassium iodide solution) along the sides of the tube. A reddish-brown precipitate denotes a positive test result.

Dragendroff's test: Add a few ml of filtrate and 1 or 2 ml of Dragendroff's reagent (Potassium bismuth iodide solution). A prominent yellow precipitate denotes a positive test result.

Detection of tannins

Ferric chloride test: Around 0.5 gm of extract was dissolved in 10 ml of water in a test tube and then filtered. A few drops of ferric chloride (0.1%) were added. Additionally, there was an apparent blue-black hue, which indicated the presence of tannins.

Test for chlorogenic acid: The test solution was treated with aqueous ammonia and then exposed to air. It had a noticeable green hue.

Detection of phenolic compounds:

Ferric chloride test: 50 milligrams of the specimen or test extract is dissolved in 5 milliliters of distilled water. Next, add a few drops of organic $FeCl_3$ solution (5%). The production of a dark green hue indicates the presence of phenolic compounds.

Lead acetate test: Three milliliters of 10% lead acetate solution are added following the sample or test extract (50 mg), which has been dissolved in distilled water. A heavy precipitate of white. Suggests that phenolic chemicals are present.

Gelatin test: 5 milliliters of distilled water dissolve the extract (50 mg), and milliliters of 10% NaCl solution are added. A simple white precipitate indicates phenolic chemicals.

Detection of triterpenoids

Salkowski test: A few drops of concentrated sulfuric acid were added to the extract. Triterpenoids are present as evidenced by the bottom layer's yellow tint.

Sulphur powder test: A tiny quantity of powdered sulfur was included in the test mixture. A sinking sulfur powder indicates the presence of triterpenoids.

Detection of flavonoids

Lead acetate test: The extract was diluted with a small amount of lead acetate suspended in ethanol. Precipitation with a golden hue was seen.

Alkaline reagent test: Drops of 10% NH_4OH should be introduced to the test solution. A strong yellow tint develops, which becomes colorless when a few drops of dilute acid are added.

Ferric chloride test: An alcoholic extract solution was added to a few drops of ferric chloride. As a result, a green color was observed.

Detection of Carbohydrates

The sample extract (100 mg) was dissolved in 5 ml of water and then filtered. The following test is performed on the filtrate:

Molisch's Test: After thoroughly shaking the mixture and adding two drops of an alcoholic alpha-naphthol solution to two milliliters of filtrate, one milliliter of concentrated H_2SO_4 was progressively poured along the test tube's side and left to stand. The violet-colored ring developed shows the presence of carbohydrates in the sample.

Benedict's Test: Add one milliliter of Benedict's reagent to 0.5 milliliters of filtrate. Heat the mixture in a water bath for two minutes until it boils. Precipitate with a distinctive hue indicates that sugar is present in the sample.

Detection of Glycoside

50 gm of the extract is hydrolyzed with concentrated HCl for 2 hours in a water bath and then filtered. Then, the following tests are performed with hydrolysate.

Bontrager's Test: After adding 2 milliliters of purified hydrolysate to 3 milliliters of chloroform and shaking it well, the $CHCl_3$ layer was quickly separated, and a 10% NH_3 solution was added. The sample contains glycosides, as evidenced by the pink tint produced.

Alkaline reagent test: Add a few drops of sodium hydroxide to a few milliliters of extract. Add a few drops of diluted solution, and it turns from a rich golden hue to colorless. HCL indicates the existence of flavonoids.

Analysis of phytochemistry:

The Kolakhar sample's physical and chemical properties, including pH, electrical conductivity (EC), total solids (TS), total alkalinity, total hardness, and the contents of Na+, K+, and Cl^-, were assessed. Deionized water was employed to prepare the AR-grade reagents used in the experiment.

Analyzing elements:

The sample was analyzed for Zn, Pb, Cd, As, and V using atomic absorption spectroscopy (AAS) with inductively coupled plasma at IIT Bombay's SAIF.

QUANTITATIVE ANALYSIS

Quantitative Assessment of Phenolic Substances:

Folin–Ciocalteu's reagent (FCR) was used to measure the total phenolic content in various solvent extracts. The process involved mixing 0.4 ml of diluted 1:10 v/v FCR with multiple quantities of the extracts. A sodium carbonate solution of 4 milliliters was added after 5 minutes. Following a 90-minute standing period at room temperature, the tubes' final amount of 10ml was added using distilled water. Using a spectrophotometer set at 750 nm, the sample's absorbance was calculated about the blank. The total phenolic content of the extract was computed as milligrams of catechol per gram of dry weight and compared to the standard graph using a calibration curve built using catechol solutions as the standard [18].

Quantitative Assessment of flavonoids

The total flavonoid concentration was ascertained using the aluminum chloride technique with catechin as a reference. A 10 ml volumetric flask was filled with 1 ml of the test material and 4 ml of water. Following five minutes, 0.3 milliliters of 10% aluminum chloride and 0.3 milliliters of 5% sodium nitrite were added. Two milliliters of sodium hydroxide (1 M) were added to the reaction mixture following a six-minute incubation period at room temperature. At once, distilled water was added to get the final amount to 10 ml. A blank spectrophotometer was used to measure the absorbance of the reaction mixture at 510 nm. As stated in [19], the results were expressed as mg of catechin/g of dried extract or catechin equivalent.

Quantitative Estimation of Alkaloids

The sample was weighed five grams into a 250-milliliter beaker, 200 milliliters of 10% acetic acid in ethanol were added, the beaker was covered, and the mixture was allowed to rest for four hours to compute the total alkaloids. The extract was then filtered and concentrated in a water bath for a quarter of its initial volume. Consistent ammonium hydroxide was added to the extract dropwise until the precipitation was completed. The whole solution was allowed to settle, and then the precipitated 28 was collected, filtered, and cleaned with diluted ammonium hydroxide [20]. The residue is the alkaloid that was dried and weighed.

Quantitative Estimation of Tannins:

The tannin content was determined using the Folin-Ciocalteu method. The sample extract, about ml, was added to a volumetric flask (10 ml) that also included 7.5 ml of distilled water, 0.5 ml of Folin-Ciocalteu reagent, 1 ml of 35% Na_2CO_3 solution, and 10 ml of distilled water. The mixture was shaken well and then allowed to sit at room temperature for half an hour. Gallic acid reference standard solutions (20, 40, 60, 80, and 100 g/ml) were

prepared in the same manner as previously mentioned. The absorbance of the test and standard solutions was measured at 725 nm against the blank using a UV/Visible spectrophotometer. One milligram of extract contained 12.1 mg of tannin, according to the tannin concentration calculation [21].

SPECTRAL ANALYSIS

FT-IR Spectroscopy

The branch of spectroscopy known as infrared spectroscopy (IR) studies light with a longer wavelength and a lower frequency than visible light, which falls into the infrared part of the electromagnetic spectrum. The Bruker Alpha-2 FT-IR spectrophotometer was used to record the infrared spectra of each extract to identify the various functional groups present in each extract. At a scan rate of 50 and a resolution of 4 cm-1, the scans were carried out between 4000 cm-1 and 500 cm-1. For every sample, the infrared (IR) spectra were acquired electronically. Three duplicates of the material were examined.

UV-visible spectroscopy

Baseline research on electromagnetic radiation in the 160–780 nm wavelength range is the basis of UV/visible molecular absorption spectroscopy. The visible (380 nm to 780 nm) and UV (160 nm to 380 nm) portions of this particular range are broadly separated for ease of reference. Because certain kinds of groups, bonds, and functional groups inside the molecule absorb radiation, it excites bonding electronic transitions, which in turn causes UV/visible light absorption in this area. By analyzing the form of the peaks, the method may be used to determine whether or not un-saturations are present and identify the existence of heteroatoms such as S and halogens. UV-SPECORD® has been utilized to perform ultraviolet-visible spectroscopy examination on the synthesized chemicals.

Antioxidant Activity

Evaluation of antioxidant activity by DPPH free radical scavenging assay. Not many changes were made to the DPPH radical scavenging activity [22][23]. 1 mL of extract (40–400 µL/mL) and 2 mL of DPPH solution (0.01% in methanol) were combined in test tubes that had been cleaned and labeled. 1,1-diphenyl-2-picrylhyrazyl(DPPH) is a type of stable free radical based on the delocalization of the additional electron on the molecule as a significant, so the molecule undimerizes. Deep violet color is obtained from the process of delocalization of electrons, identified from an absorption band in ethanol solution with a wavelength of almost 517 nm. After adding the layer with a solution of DPPH, it can produce hydrogen atoms; after that, the reduced form can be clarified by replacing the violet color. For evaluating the antioxidant potential from free radical scavenging of the test sample, the optical density change of DPPH radical is closely seen. The sample extract (0.2ml) was diluted with methanol, and 1ml of DPPH solution was added. Absorbation is noticed after 30 minutes. The following formula can calculate the calculation of DPPH radical scavenging –

% of inhibition of DPPH radical= (A blank – B sample)/Ablank×100 Where A blank is the absorbance of the control reaction and B sample is the absorbance of the test compound [24].

Antimicrobial Activity:

The degree of growth inhibition was measured in various bacterial species, including Aspergillus. niger, Pseudomonas aeruginosa, Escherichia coli, and Staphylococcus aureus. The medium was made with distilled water, sterilized for 15 minutes at 121°C in an autoclave, and then allowed to cool at ambient temperature. Sterile discs were treated with extracts from each solvent at varying concentrations. After being sterilized, bacterial cultures were introduced onto discs and allowed to incubate [25].

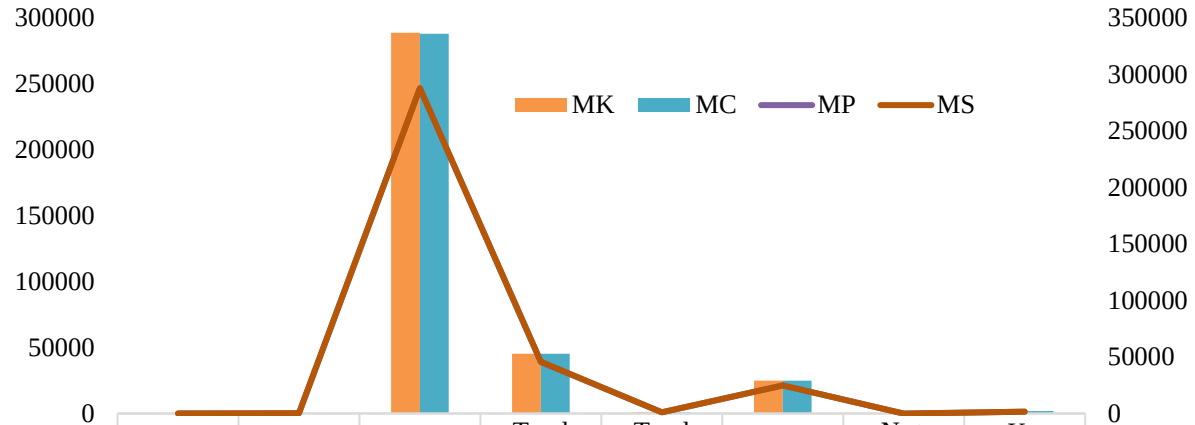
RESULTS

The results for physicochemical and elemental are presented in Table 1 and Table 2, respectively.

Table 1: Physicochemical parameter results of kolakhar

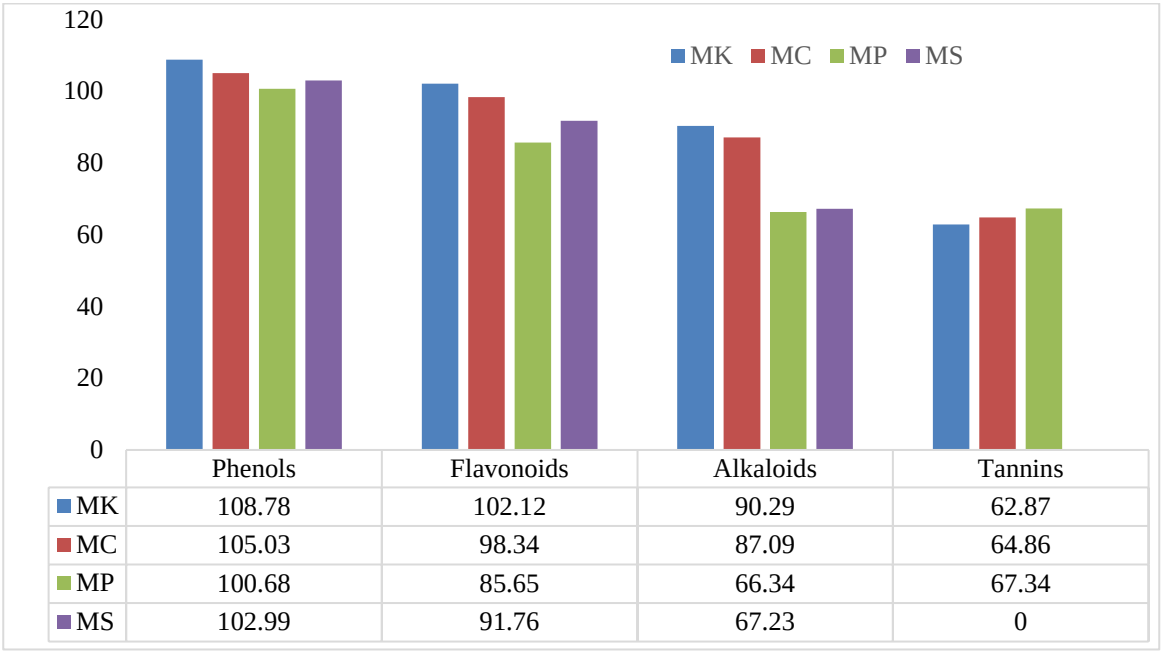
Parameters	**MK**	**MC**	**MP**	**MS**
pH	13.0	12.05	12.0	13.01
EC (mS/cm)	84.0	85.0	84.0	83.0
TS (ppm)	288900	288200	288100	288100
Total alkalinity (ppm)	45400	45390	45392	45890
Total hardness (ppm)	941	938	937	939
Chloride (ppm)	24852	24849	24848	24847
Na+ content (ppm)	16.6	16.2	16.1	16.0
K+ content (ppm)	1741	1739	1737	1740

MK: Musa balbisiana; MC: Musa champa; MP: Musa paradisiaca MS:Musa splendida



	pH	EC (mS/cm)	TS (ppm)	Total alkalinity (ppm)	Total hardness (ppm)	Chloride (ppm)	Na+ content (ppm)	K+ content (ppm)
MK	13	84	288900	45400	941	24852	16.6	1741
MC	12.05	85	288200	45390	938	24849	16.2	1739
MP	12	84	288100	45392	937	24848	16.1	1737
MS	13.01	83	288100	45890	939	24847	16	1740

Figure 1: Physicochemical parameter results of kolakhar



	Phenols	Flavonoids	Alkaloids	Tannins
MK	108.78	102.12	90.29	62.87
MC	105.03	98.34	87.09	64.86
MP	100.68	85.65	66.34	67.34
MS	102.99	91.76	67.23	0

Figure 2: Quantitative determination of phenols, flavonoids, alkaloids, and tannins in aqueous extract of 4 selected banana peel

DISCUSSION

The physicochemical parameters provide an overview of the chemical characteristics of kolakhar, which contribute to its unique properties in both traditional medicine and culinary application, as shown in Table 1 and Figure 1.

AAS provides a detailed profile of the metal content in kolakhar, which is crucial for understanding its chemical properties, nutritional value, and safety for consumption. This has been shown in Table 2. The studies above demonstrated that the C=O and hydroxyl O-H stretching vibrations were attenuated following infrared (IR) measurement of the banana peel. *Musa balbisiana Colla*, *Musa champa baker*, *Musa paradisiaca*, and *Musa splendida* have been found to contain a functional group similar to an isothiocyanate, which could be benzyl glucosinolates (O- glycosylated glucosinolates) with an

additional sugar moiety, such as rhamnose or arabinose, connected to the aromatic ring by a glycosidic bond, according to FT-IR analysis have shown in Table 4.

The presence of heteroatoms like S and halogens and the presence or absence of unsaturations that may be detected by UV-visible spectroscopy has been shown in Table 5. The curious thing about this plant family frequently used for its medicinal qualities is that these sugar moieties are present, even if their importance is unclear. The results also demonstrated the 34 considerable antioxidant activity of aromatic isothiocyanates. It was discovered that the chemical structure of aromatic isothiocyanate and DPPH were the key contributing elements in this respect. DPPH radical scavenging tests were conducted to acquire a clear profile of the antioxidant capacity of banana peel extracts since these assays have been widely used to evaluate the antioxidant effects of other fruit and vegetable extracts.

Table 2: Elemental analysis of kolakhar by AAS

Elements	Concentration (ppm)			
	MK	MC	MP	MS
Zn (ppm)	0.027	0.026	0.026	0.025
Pb (ppm)	< 0.01	< 0.01	< 0.01	< 0.01
Cd (ppm)	< 0.01	< 0.01	< 0.01	< 0.01
V (ppm)	0.4	0.4	0.4	0.4
As (ppm)	< 0.01	< 0.01	< 0.01	< 0.01

Table 3 and Figure 2 illustrate how the concentration-dependent DPPH scavenging capacities of all four banana extracts increased. When comparing the DPPH 2 scavenging capacity of the extracts, Musa balbisiana showed the highest level. *Musa balbisiana*, *Musa champa*, *Musa paradisiaca*, and *Musa splendida* had EC50 values of 0.690±0.07, 0.501±0.25, 0.499±0.21, and 0.578±0.43µg/ml, respectively, derived from their DPPH scavenging activities have shown in Table 6. The findings demonstrated an inhibitory impact on Gram-negative bacteria, with an inhibition zone measuring 15–35 mm. S. aureus exhibited the highest susceptibility to banana peel extract, followed by *E. coli, C. albicans, and A. niger*, which showed the lowest susceptibility, as shown in Table 7.

Table 3: Quantitative determination of phenols, flavonoids, alkaloids, & tannins in aqueous extract of 4 selected banana peel

S No	Constituents	MK	MC	MP	MS
1	Phenols	108.78	105.03	100.68	102.99
2	Flavonoids	102.12	98.34	85.65	91.76
3	Alkaloids	90.29	87.09	66.34	67.23
4	Tannins	62.87	64.86	67.34	-----

Table 4: FT-IR spectroscopy results of Aqueous Extract of 4 selected banana Peel

IR (KBr) v/(cm^{-1})	
MK	3344.34(OH st.), 2361.72(C=O st.), 2096.32(N=C=Sst.),1635.43(C=C,st.),1382.52 (C-H, st), 1044.39(C-Nst.)
MC	3341.34(OH st.), 2357.87(C=O st.), 2120.19(N=C=Sst.), 1634.13(C=C,st.), 1359.98 (C-H, st)
MP	3341.03(OH st.), 2111.21(N=C=Sst.), 1634.13(C=C,st.), 1360.32 (C-H, st)
MS	3342.34(OHst.),2361.40(C=Ost.),2100.63(N=C=Sst.), 1634.12(C=C,st.)

Table 5: UV-visible spectroscopy results of Aqueous Extract of 4 selected banana Peel

Sl. No		λmax
	MK	245
1	**MC**	243
2	**MP**	244
3	**MS**	243

Table 6: DPPH searching ability of four banana peels

Concentration (µg/ml)	MK	MC	MP	MS	Ascorbic acid
10	0.301±0.01	0.300±0.13	0.298±0.67	0.290±0.43	0.352±0.54
20	0.408± 0.24	0.390±0.28	0.300±0.43	0.397±0.65	0.501±0.65
40	0.576±0.42	0.476±0.12	0.407±0.78	0.532±0.12	0.613±0.19
60	0.690±0.07	0.501±0.25	0.499±0.21	0.578±0.43	0.728±0.31

Table 7: Results of Antimicrobial activity of kolakhar

Sample	Zone of inhibition (mm)			
	S. aureus	*E. coli*	*C. albicans*	*A. niger*
MK	35±0.02	23±0.76	------	15±0.91
MC	28±0.98	21±0.89	0.7±1.03	10±0.23
MP	20±0.23	18±0.56	0.5±1.02	-----
MS	23±0.34	15±0.24	-----	12±0.43
Std1.	38±0.21	28±0.02	------	-----
Std2.	-----	-----	24±0.06	20±0.12

Std.01: Ampicilin; Std.02: Ketoconazole [N=3]

CONCLUSION

This investigation sought to determine the antioxidant capacity of four species: *Musa paradisiaca, Musa balbisiana Colla, Musa champa baker*, and *Musa splendida*. We have conducted several further investigations to explore the plant, including phytochemical and antioxidant tests. *Musa balbisiana Colla, Musa champa baker, Musa paradisiaca*, and *Musa splendida* filtrate of ash were used for the initial phytochemical assay. According to the screening, the bark filtrate included protein, glycoside, phenolic substance, and carbohydrates. In the future, plants may be utilized medicinally since they contain active phytochemicals. Though their significance is uncertain, it is intriguing that these sugar moieties occur in this widely used medicinal plant family. The results further showed that aromatic isothiocyanates had considerable antioxidant action. The main factors that contributed to this were the chemical structure of the aromatic isothiocyanate and DPPH. It has been utilized historically since ancient times as a food additive and for various medical conditions. A thorough scientific examination might be beneficial in assessing the pharmacological actions of different chemical ingredients. The biological properties of banana peels as antioxidants were the main focus of this study. Polyphenolic chemicals, alkaloids, flavonoids, tannins, saponins, glycosides, carotenoids, sterols, triterpenes, and catecholamines were among the components in the peels that showed antioxidant activity. The banana peel turned out to be a very promising finding for further research in the future. Additional research is required to find the biologically active components, potential uses, and additional benefits of banana peels beyond what they currently serve as a waste product. We may infer that the food, pharmaceutical, and other industries can profitably employ banana peels. To completely clarify the medicinal advantages and real-world uses of these extracts, more investigation, including in-vivo investigations and clinical trials, is necessary. Adopting such sustainable techniques helps the environment, reduces waste, and provides financial gains. In conclusion, more research is needed to fully realize the potential of banana peel extracts for both industrial and health uses. They show great promise.

FINANCIAL ASSISTANCE

NIL

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

Faruk Alam contributed substantially to the conception, design, analysis, and interpretation of data; Avik Dutta was involved in drafting the article or revising it critically for important intellectual content; Alindam Ghosh contributed to data acquisition. Rinchi Bora collected, authenticated, and extracted the plant materials. Soumya Sunder Ghora performed phytochemical and quantitative analysis. Saurav Guchhait performed antibacterial effects and contributed to the compilation and analysis of data. Arijit Mallick performed antioxidant effects and contributed to the study and compilation of data.

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