

# A COMPREHENSIVE REVIEW ON MUSA PARADISIACA TAXONOMICAL, MORPHOLOGICAL CLASSIFICATION AND ITS PHARMACOLOGICAL ACTIVITIES

Dr. Durgaprasad Kemiseti<sup>1</sup>, Rajeswar Das<sup>2\*</sup>, Dr. Bolay Bhattacharya<sup>3</sup>

<sup>1</sup> Associate Professor, Faculty of Pharmaceutical Science, Assam down town University, Panikhaiti, Guwahati, Assam 781026.

<sup>2</sup> Assistant Professor, School of Pharmacy, The Neotia University, Diamond Harbour Road, Sarisha, West Bengal 743368.

<sup>3</sup> Professor and Head, Sister Nivedita University, DG Block, Newtown, West Bengal 700156.

**Corresponding Author:** Rajeswar Das, Assistant Professor, School of Pharmacy, The Neotia University, Diamond Harbour Road, Sarisha, West Bengal 743368.

Email id: [rajeswar.das95@gmail.com](mailto:rajeswar.das95@gmail.com), Orcid id: 0000-0003-2789-3972

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## Abstract

one of the most frequently cultivated plant species and serves as the primary source of nutrition for both people and animals in a number of different places. It is equipped with a wide variety of helpful characteristics. In the practise of traditional medicine, the fruits, in addition to other components of the plant such as the stem, peel, pulp, and leaf, are utilised to treat a wide range of human conditions. In this essay, we will discuss the research that has been conducted on the medicinal uses, nutritional benefits, and phytochemical makeup of this particular species of Musa. It is an excellent source of carbohydrates that may be broken down into glucose as well as a plethora of other nutrients, such as the B vitamins, vitamin C, and a variety of minerals, such as potassium, calcium, and magnesium. According to the findings of a number of in vitro studies, in vivo studies (animal model studies), and clinical trials, numerous parts of bananas and plantains have been used in traditional medicine to treat a wide variety of non communicable diseases, such as diabetes, cancer, hypertension, diarrhoea, ulcers, analgesic, and depression. It is also examined what possible mechanisms and associated phytochemicals are involved in the biological activity of the various extracts.

**Keywords:** *Musa paradisiaca*, Pharmacological activity, Anticancer activity, Anti microbial activity, Taxonomical classification.

## Introduction

Bananas originate from a blooming herbaceous plant, while plantain, also known as *Musa paradisiaca* Linn., is a common ingredient in culinary preparations<sup>[1]</sup>. Even though it is said to have originated in India and the rest of southern Asia, it is currently farmed over the entire subtropical and tropical regions of Africa, not just in Nigeria. Plantains are an important part of the diet of many indigenous peoples that make their home in the subtropics. Each year, Nigeria produces approximately 2.11 million metric tonnes worth of plantains<sup>[2,3]</sup>. It is common knowledge that bananas are one of the least expensive, most commonly available, and healthiest foods in the entire humid and temperate part of the earth. This is because bananas are harvested at a pace of approximately 10 million per hectare. In the most recent decades, conventional medical practises and overall traditional medical systems have garnered a significant amount of attention and acceptance<sup>[4]</sup>. It is abundantly obvious that humanity continue to rely on nature as a source of healing, as evidenced by the fact that medications derived from plants

form the backbone of all of the primary medical systems, including Ayurveda, Unani, and Homeopathy. The investigation of traditional herbal treatments from the point of view of modern science is required in order to ensure that traditional plant medicines are applied in an effective and appropriate manner<sup>[5,6]</sup>. The World Health Organization (which has recognised the importance of herbal therapy for a long time) has lately issued a number of resolutions with the goal of boosting the safety and effectiveness of herbal remedies. These resolutions aim to improve the overall quality of herbal treatments. *Musa paradisiaca*, a tree native to tropical regions, is a member of the family Musaceae<sup>[7]</sup>. As a result of the presence of 'false aerial branches and sheathing leaves developing from a rhizome,' the plants are categorised as giant herbs. The Indian subcontinent is home to numerous cultivations of this plant. In many different types of traditional medicine, parts of the banana plant other than the fruit itself are utilized<sup>[8]</sup>. Anemia, syphilis, and various other blood and genital problems can all be treated using the roots and stems of this plant, which have been used medicinally for generations. Fruit that is harvested before it reaches its peak sweetness and is consumed in conjunction with other diabetes treatments<sup>[9]</sup>. Flower juice mixed with curds has been shown to be effective in treating both dysentery and menorrhagia. Using a cold therapy that is created from the leaves of young plants, blisters and burns can be treated successfully. In addition to the plant's conventional applications, there are a number of papers that detail strong pharmacological activity associated with the banana plant<sup>[10]</sup>.

*Musa*, *Ensete*, and *Musella* are the three separate genera that can be found within the family Musaceae. This family also contains *M. paradisiaca*. *Musa* is the most diverse of the three groupings, including over 35 distinct species altogether, including, but not limited to, *Musa acumiata*, *Musa balbisiana*, and *Musa sapientum*<sup>[11]</sup>. *Musa* species can be broken down into a great number of different subgroups. The most recent research in genetics has revealed that the genus *Musa* is composed of three distinct subgroups: *Musa*, which has 22 chromosomes; *Callimusa*, which has 20 chromosomes; and *Ingentimusa*, which has 18 chromosomes (with 14 chromosomes). *M. paradisiaca* can grow to a maximum height of 9 metres, and depending on the species and the nutrients in the soil, it can produce fruits that are either yellow or green in colour, do not contain seeds, and can be up to 7 centimetres in length<sup>[12]</sup>. The wind disperses the *M. paradisiaca* plant's seeds, which fall from the long, thin spikes that glisten above the surrounding vegetation. When compared to other types of herbaceous plants, *M. paradisiaca* thrives on soils that have been compacted to a greater degree. Alongside paved sidewalks, roadways, riverbanks, and other locations that have relatively level ground, it can be found growing in quite large quantities. This unwanted plant can be seen growing wild in savannas as well as croplands. The starch contained within the meal produced by *M. paradisiaca* is extremely beneficial to the health of both humans and animals across South and Central America, Asia, and Africa. Over 600 million people in Africa depend on *M. paradisiaca* as their primary source of daily food energy, as it provides them with more than 200 calories on average. Recent evidence suggests that plants are going to play an increasingly significant role as a source of primary medicines. As a form of medical treatment, the consumption of plants and plant parts is common practise in economically disadvantaged nations like Nigeria, for example<sup>[13]</sup>. It's possible that the trend toward using natural resources rather than medications created by humans or the prohibitively expensive expense of standard medical care is to blame. A significant number of today's medications are produced from plant sources. Digitoxin is produced from the plant *Digitalis lanata*, *Chinchona officinalis* is the source of quinine and quinidine, *Catharanthus spp.* is the source of vinblastine and vincristine, *Atropa spp.* is the source of atropine, and *Papaver spp.* is the source of codeine and morphine. *M. paradisiaca* has been the focus of intensive ethnopharmacological and ethnobotanical research because of its potential for both medical and economical benefit. As a result of this research, a broad variety of intriguing properties in the numerous components of *M. paradisiaca* have been uncovered. The majority of these features of the plants are attributable to the fact that indigenous peoples traditionally used them for medicinal purposes. The bioactive compounds and minerals that can be extracted from *Musa paradisiaca* have been utilised in the diagnosis, treatment, and ongoing management of a wide variety of illnesses. When fermented and then extracted with water, for instance, the unripe peels and fruits of *M. paradisiaca* have shown to have anti-ulcerogenic effect. In addition, hydroxyanigorufone was discovered in *M. paradisiaca*, and its potential use as a cancer chemopreventive agent was investigated. In addition to this, 12 different polyphenols were identified and quantified in the methanolic extract of plantain inflorescence, and it was found that 12.54% of the dietary fibre in plantain inflorescence is due to the presence of these polyphenols in the flower<sup>[13,14]</sup>. Polyphenols such as these have demonstrated considerable potential as a potential defence mechanism against diabetes and cardiovascular disease. Dietary fibre extracted from plantain inflorescence serves as a container for biologically active substances

after first being characterised as a matrix. This step follows the characterization of the fibre. The production of these biologically active compounds enhances the health of the digestive tract and lowers the chance of developing colon cancer when they are paired with probiotic bacteria, which helps fermentation along. In this piece, we'll investigate the nutritional value, pharmacological mechanism, and phytochemical properties of the *M. paradisiaca* plant, as well as what we now know about them.

### Geographical distribution

It is a perennial plant that may grow to heights of ten to forty feet, giving it the appearance of a tree, and it can be found all across the tropics and subtropics. Its natural habitats span the entire tropical expanse of India and Burma. The biggest numbers of individuals belonging to this species can be found in the Indian states of Tamil Nadu, Andhra Pradesh, Bihar, Madhya Pradesh, West Bengal, Maharashtra, and Gujarat<sup>[15,16,17]</sup>. The tropics of the Americas, Australia, and Africa all fall within its natural habitat, making it one of the most widespread species in the world. There are only a few places in the globe where the plant may be farmed, and those places are Florida, the Canary Islands, southern Egypt, southern Japan, and southern Brazil.

Fig 1: *Musa paradisiaca*



### Morphology<sup>[16,17]</sup>

**Habit:** One of the tallest herbaceous plants, *Musa paradisiaca's* pseudostem is created by the imbricate leaf sheaths and is soft and succulent. A substantial rhizome is another distinguishing feature (up to 9 m in length).

**Flower:** The inflorescence, which begins at the top of the false trunk and spirals downward, produces clusters of androgynous flowers first. After that, the inflorescence generates clusters of female flowers. Flowers are comprised of an upper ovary and five stamens.

**Fruit:** The cultivated versions of this berry typically do not contain seeds and take on a morphology that is fleshy and long. The exterior layer of fresh fruits has a bluish-green hue, is glossy, and is mucilaginous; in contrast, the inner layer of fresh fruits is white in colour, powdery, and contains very few seeds, if any at all.

**Leaves, stem, root:** This evergreen plant has the potential to grow to a height of 6 metres. The leaves are most accurately described as being enormous, unbroken, and straightforward. In most cases, they take on a pinnatifid shape and originate from a rhizome that grows underground. The dried out leaf bases cluster together to form a fake trunk.

**Parts used:** Fruit, leaves, stem

**Taxonomical classification<sup>[15]</sup>**

<i>Kingdom</i>	<i>Plantae</i>
<i>Sub kingdom</i>	<i>Tracheobionta</i>
<i>Superdivision</i>	<i>Spermatophyta</i>
<i>Division</i>	<i>Magnoliophyta</i>
<i>Class</i>	<i>Liliopsida</i>
<i>Subclass</i>	<i>Zingiberidae</i>
<i>Order</i>	<i>Zingiberales</i>
<i>Family</i>	<i>Musaceae</i>
<i>Genus</i>	<i>Musa L.</i>
<i>Species</i>	<i>Musa paradisiaca Linn</i>

**Phytochemical constituents**

Tannin and gallic acid are components of the plant that are found in the vegetative parts of the plant. Roughly 22 percent of the mature fruit is made up of sugar, 4.8 percent of the starch, 1 percent of the fat, and 6 to 13 percent of the extractives that are not nitrogenous. It has a somewhat high vitamin C content, as well as modest vitamin B content<sup>[18]</sup>. It was in unripe bananas that researchers first found the flavonoid that is now known as leucocyanidin. The mineral makeup of the fruit includes magnesium, iron, potassium, zinc, copper, phosphorus, aluminium, sodium, manganese, and nitrogen. Manganese is also present in the fruit. In the fruit, there are high concentrations of molecules of varying sizes, including both small and large. The immature fruit is abundant in calcium and selenium, but the ripe fruit has a significantly larger quantity of phosphorus and manganese in it. Aspartic acid, glutamic acid, and leucine are the three amino acids that are found in mature fruit in the greatest quantities<sup>[19]</sup>. The fruit contains a compound referred to as sitoindoside IV, which is an acylsteryl glycoside. The ash of the mature fruit husk contains a number of different minerals, including carbonates of potash and soda, chloride of potassium alkaline phosphates, lime silica, and others. The green plantain contains a significant amount of tannin. The juice that is extracted from the stems of plantain flowers contains a variety of different chemicals, some of which are listed below: potash, soda, lime, magnesium, alumina, chlorides, sulphuric anhydride, phosphoric anhydride, silica, and carbon anhydride.

## Pharmacological Activity

### Antimicrobial activity

In recognition of the importance and practicality of herbal medicine, the World Health Organization (WHO) has, over the course of its history, put into action a number of long-term plans and resolutions with the objective of improving the efficiency and quality of pharmaceuticals derived from plants<sup>[23]</sup>. As a direct consequence of this, there has been a growth in the amount of scientific inquiry on the justification and basis of their traditional use (WHO 2013). There has been a clear improvement in the scientific understanding of traditional and complementary medicine since the World Health Organization (WHO) published the first series of Traditional Medicine Strategy publications (2002-2005). As a consequence of this, standards and protocols have been developed in order to ensure the delivery of herbal medicine services in a systematic manner (WHO 2013)<sup>[24]</sup>. The antibacterial activities of the plantain (*M. paradisiaca*) have been demonstrated in a number of investigations, with a wide variety of organisms serving as test subjects (most commonly fungus and bacteria, but also parasites and viruses). Asoso et al. (2016) demonstrated the antibacterial activity of plantain peel and fruit extracts against *Escherichia coli*, *S. aureus*, *Salmonella*, *Shigella*, *Klebsiella pneumonia*, and *Bacillus subtilis*. The researchers used the agar well diffusion method to conduct their research. The minimum inhibitory concentration (MIC) for the ethanolic peel extract ranged between 150 and 200 mg/mL when tested against *S. aureus* strain 25923 ATCC, *Salmonella typhi* strain 22648 ATCC, and *Klebsiella pneumonia* strain 34089 ATCC, respectively<sup>[25]</sup>. The minimum inhibitory concentrations (MICs) of fruit ethanol extracts ranged from 200 to 300 mg/mL. On the other hand, the minimum inhibitory concentrations (MICs) for methanolic extracts of peels and fruit were 100 and 200 mg/mL, respectively, whereas the MICs for fruit extracts ranged from 150 to 250 mg/mL. Extracts of acetone generated either from fruit peels or fruits themselves did not exhibit any antibacterial activity against the various test isolates. Even though there was indications of activity, differentiation based on Gram reactivity to the cell wall could not be found. This suggests that the mechanism of activity did not include cell wall lysis as one of its components. An ethanolic extract of peel powder has been shown to be beneficial against opportunistic skin infections such as *Propionibacterium acnes*, which is now known to be *Cutibacterium acnes*, and *S. epidermidis*. This potential use is supported by Prakash et al. (2017), who discovered an inhibitory effect against *Aspergillus niger*, the fungus that is now believed to be responsible for cases of tinea capitis (Chokoeva et al. 2016). In order to determine whether or not the ethanolic and ethanolic and aqueous (1:1) extracts of *M. paradisiaca* flowers are effective against fungus, Jawa et al. (2012) conducted a microdilution experiment. The MIC values for these extracts ranged from 5.62-25.81 µg/mL and 7.61-31.58 µg/mL, respectively. The minimum inhibitory concentration (MIC) of *Candida albida* MTCC-2661 was determined to be 6.49 and 7.61 µg/mL for ethanolic extracts and ethanolic and aqueous extracts, respectively. *C. albicans* MTCC-183 fared marginally better than the other strains, with ethanolic extracts average 8.62 g/mL and extracts including a mixture of ethanol and water (1:1) averaging 9.88 µg/mL. The minimum inhibitory concentrations (MICs) for ethanol in three different bacterial isolates *Pseudomonas aeruginosa* ATCC-9027, *Bacillus subtilis* MTCC-121, and *Bacillus cereus* MTCC-430 ranged from 5.62 to 7.95 µg/mL, respectively, whereas *Salmonella typhimurium* MTCC-98 showed the highest ethanolic MIC<sup>[26]</sup>. The MIC for *E. coli* MTCC-443 was found to be the highest in both the ethanolic and the aqueous (1:1) extracts. *Streptococcus pneumoniae* MTCC-2672 came in second place with a value of 24.86 µg/mL, and then *Proteus mirabilis* MTCC-1429 came in third with a value of 22.13 µg/mL. We have come to the conclusion that the amount of water present in the ethanolic and aqueous (1:1) extract is responsible for explaining why, on average, ethanolic extracts were active at lower doses compared to the ethanolic and aqueous (1:1) extract. After that, the investigators tested the extract for acute and short-term toxicity using models of albino Wistar rats, and they discovered no evidence of toxicity or morbidity. The fact that this study did not include a phytochemical assay means that the activity that was described by Ahmad et al. (2015) cannot be connected to a particular group of phytochemicals. According to the findings of the scientists, glycosides, flavonoids, phenols, and saponins were present in the ethanolic and methanolic extracts that were obtained using cold extraction. However, saponins were not found in the extracts that were made with water<sup>[24,25]</sup>. In Oyeyinka and Afolayan's (2019) proximate analysis of fresh, peel, and peel aqueous extract, they report the presence of fat, moisture, carbohydrates (which dominate at around 68%), fibre, and minerals including potassium, nitrogen, phosphorus, calcium, sodium, and magnesium, in that order of quantity, with trace elements such as zinc, copper, iron, and manganese present in minute quantities. Additionally, they report the presence of trace elements including It is important to note that the pulp,

the peel, and the extracts of the peel all followed the same pattern of amount progression. In addition, there were only trace amounts of several antinutrients such phytate and oxalate (below the WHO guidelines). The findings of this research demonstrate that plantain has a diverse range of phytochemicals and nutrients, which provides sufficient rationale for the widespread application of plantain<sup>[26]</sup>. However, it is concerning that the pulp may dramatically limit the absorption of quinolones, and that co-administration may impair ciprofloxacin's effectiveness against *E. coli*. Both of these factors can be affected by co-administration. This raises problems regarding the dynamics of the interactions and affects that medications have on one another, for which there is currently a paucity of evidence. According to Chabuck et al research, it has been demonstrated that an aqueous extract of plantain peel possesses antibacterial properties (2013). An aqueous extract of fresh yellow plantain peel was subjected to testing against two Gram-positive bacteria (*S. aureus* and *S. pyogenes*), four Gram-negative bacteria (*Enterococcus aerogenes*, *Klebsiella pneumoniae*, *E. coli*, and *Moraxella catarrhalis*), and a yeast isolate. All of the bacteria were tested for their ability to inhibit the growth of the yeast (*Candida albicans*). *Mycobacterium catarrhalis* and *Staphylococcus aureus* were the microbiological isolates that the aqueous extract of fresh plantain peel was most successful against. After that, the efficiency of antibiotics against *Streptococcus pyogenes*, *Enterococcus faecium*, and *Klebsiella pneumoniae* decreased, respectively<sup>[27]</sup>. On the other hand, there was no effect found against *E. coli* and *Candida albicans*, which suggests that these organisms have an innate resistance. Conducted research to investigate the potential antibacterial properties of an alcoholic extract of plantain peel against two Gram-negative, anaerobic periodontal pathogens: *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans*. The minimum inhibitory concentration (MIC) for both *P. gingivalis* and *A. actinomycetemcomitans* was found to be 31.25 µg/mL when testing was conducted using the serial broth dilution method. Due to the fact that the research did not include any studies to determine the mechanism of action, it is challenging to attribute an inhibitory pathway to the observation. On the other hand, the observed impact can be attributed to the synergistic effect of ethanol and phytochemicals, both of which possess antibacterial properties.

When treated with hexane, ethyl acetate, and methanol, Karuppiyah and Mustafa showed that the leaf extracts of numerous banana species, including *Musa paradisiaca*, have an antibacterial effect (2013). As test organisms, *Escherichia coli*, *Pseudomonas aeruginosa*, *Citrobacter* species, and other bacteria that have been associated with hospital-acquired infections were used to investigate the antibacterial activity of the compounds. According to the findings of the research, extracts made using ethyl acetate were more effective than those made with methanol, which in turn were superior to extracts made with hexane<sup>[25-27]</sup>. When contrasted with the efficacy of chloramphenicol, however, the effectiveness of ethyl acetate extracts was more variable. Both *P. mirabilis* and *E. aerogenes* were resistant to the hexane extracts' attempts to kill them. The MIC for the ethyl acetate extract was the lowest, ranging from 15.00 to 125.00 µg/mL, while the MIC for the hexane extract was the highest, ranging from 125.00 to 250.00 µg/mL. The MIC for the methanolic extract was 15.63 to 250.00 µg/mL. In ethyl acetate and methanolic extracts, the bactericidal concentration varied from 31.25 to 250.00 µg/mL, whereas in hexane extract, the range was 250.00 µg/mL. The bactericidal concentration was shown to be most effective against *Escherichia coli*, followed by *M. acuminata*, *M. sapientum*, and *M. troglodytarum*. Because certain extracts needed relatively large concentrations to have inhibitory or bactericidal action, this research had one and only one limitation: a toxicity investigation would be required to verify that it was safe. This was the only drawback. It has been discovered that the acute toxicity LD50 for an aqueous extract is lower than that of an ethanolic extract (489.9 mg/kg;), indicating that an effective dose may be detrimental. The use of an aqueous extract allowed for the discovery to be made. Results similar to those found by Amutha and Selvakumari were found in their study (2016). They reported a minimum inhibitory concentration (MIC) of 0.5 mg/mL for *P. aeruginosa* and 1.0 mg/mL for *S. aureus*. Additionally, the inhibition zone (mm) ranked third for *P. aeruginosa* following gentamicin and ranked second for *S. aureus* following chloramphenicol and novobiocin. Researchers reported the in vitro antimicrobial activities of a dichloromethane and methanol (1:1) extract of *M. paradisiaca* fruit peels against *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Candida albicans*, *Candida tropicalis*, and *A. niger*. They used the agar well disc diffusion method to According to the findings, the extract made from the *M. paradisiaca* plant was more effective than the extract made from the *Cocos nucifera* tree in combating the various test isolates.

## Antidiabetic activity

An elevated blood glucose level is a hallmark of diabetes, also known as hyperglycemia. A malfunction in glucose metabolism causes this unusually high blood glucose level. Diabetes mellitus can be divided into two subtypes: type 1, which calls for insulin treatment, and type 2, which does not. Loss of pancreatic beta cells is the cause of type 1 diabetes, which results in low levels of insulin being released into the blood; however, this disease is curable with the use of insulin therapy<sup>[28]</sup>. Diabetes type 2, on the other hand, manifests itself either as a result of a reduced response of the body to insulin production or as a result of insulin not being utilised in an adequate manner. Researchers have investigated the effects of *M. paradisiaca* on diabetic activities using both in vitro and in vivo research methods. The effects of *M. paradisiaca* leaf, fruit, and peel extracted with hydroethanolic solvent as an antihyperglycemic were tested, and the possible mechanism of actions was discussed, using nicotinamide (NA) and streptozotocin (STZ) caused diabetic rats. In NA and STZ-induced diabetic rats treated with a hydroethanolic extract of *M. paradisiaca* leaf, fruit, and peel, blood levels of the pro-inflammatory cytokines interleukin 6 (IL-6) and tumour necrosis factor-alpha (TNF-  $\alpha$ ) were reduced, providing support for the effectiveness of *M. paradisiaca* as an anti-inflammatory agent. Myeloid cells are responsible for the bulk of TNF-  $\alpha$  secretion after NF-B and MAP kinase activation; TNF-  $\alpha$  is a potent proinflammatory cytokine. This activation is necessary for TNF- to be produced. Because of this activation, inflammatory cytokines including interleukin (IL)-1 and IL-6 are allowed to be released into the bloodstream<sup>[29]</sup>. TNF  $\alpha$  also upregulated insulin receptor substrate-1 (IRS-1) and insulin receptor phosphorylation (IRP) on threonine or serine residues, both of which contribute to insulin antagonist activity. IRS and IRP mutations at threonine or serine reduced tyrosine phosphorylation by PKC, NF-B, and a regulatory protein kinase. Additionally, these mutations hindered the activation of PI3K and PKB (I). A decrease in the process of tyrosine phosphorylation is the root cause of insulin resistance. Both the TNF-  $\alpha$  and the down regulation of adipocyte complement-related protein of 30kDa (Acrp30) mRNA levels are necessary to accomplish the goal of keeping lipid and peripheral glucose homeostasis stable<sup>[30]</sup>. Further enhancing the defective insulin signal transduction pathway and glucose absorption, TNF-  $\alpha$  also greatly increases fatty acid (FFA) release and lipolysis by decreasing expression of Gi protein and increasing expression of lipid droplet-associated protein. This occurs because TNF- decreases expression of Gi protein and increases expression of lipid droplet-associated protein (perilipin). In NA and STZ-induced diabetic rats treated with hydroethanolic extracts of *M. paradisiaca* leaves, fruits, and peels, there was an increase in the expression of PPARc, GLUT4, Acrp30, and insulin receptor -subunit in adipose tissue<sup>[31,32]</sup>. There was also a drop in the blood FFA level. The expression of adipose tissue-specific factor (resistin) was dramatically suppressed in diabetic-induced rats when they were given hydroethanolic solvent extracts of the leaves, fruits, and peels of *M. paradisiaca*. According to the findings of this research, the ability of *Musa paradisiaca* to control resistin could point to the plant's potential use in the treatment of diabetes<sup>[34-36]</sup>.

## Antihypertensive activity

A medical condition known as high blood pressure, sometimes known as hypertension. Long-term hypertension has been associated to a number of cardiovascular diseases (CVDs), including heart attack, stroke, and heart failure. In a similar manner, it is commonly acknowledged that the fundamental driver of cardiovascular disease is oxidative stress-induced heart inflammation<sup>[37]</sup>. The Renin-angiotensin system (RAS) is a hormone system that is involved in the control of fluid balance, blood pressure (BP), and salt. The pathophysiology of cardiovascular disease (CVD) includes this system. Angiotensinogen is first changed into angiotensin I by the enzyme renin. Next, angiotensin I is changed into angiotensin II, which is a potent vasoconstrictor (ACE). Although there is some evidence that *M. paradisiaca* has been used in traditional medicine to treat or prevent hypertension, there is a lack of data on whether or not the peels (unripe, ripe, and over-ripe) that represent a waste problem actually have any antihypertensive effect. This is a problem because the peels are a problem because they represent a waste problem<sup>[38]</sup>. We were able to evaluate the antihypertensive potential of the extracts by first characterising the interaction of the aqueous extract of the peels with ACE, an enzyme that is believed to be effective in therapeutic approaches to the control or treatment of high blood pressure<sup>[39]</sup>. Peels may have had therapeutic benefits because to the highly inhibitory effects of water-extractable phytochemicals. These phytochemicals were found in the peels. In addition, the hypotensive effects of deoxycorticosterone enanthate (25 mg/rat) and ripe banana pulp (50

gm/rat/day) were investigated in rats that had become hypertensive as a result of the administration of deoxycorticosterone enanthate<sup>[40-42]</sup>. Serotonin levels, which are responsible for mediating natriuretic effects, are raised as a result of this as a result of the high tryptophan and carbohydrate content in ripe banana pulp<sup>[43]</sup>. In addition, Orié mentioned that the effect of plantain aqueous extract was established on the basis of its concentration-dependent hypotensive (CDH) effect on norepinephrine and potassium chloride (KCl) contracted aortic rings and portal vein isolated from rats. From that point forward, *M. paradisiaca* could be incorporated into the investigation and manufacture of nutraceuticals related to hypertension.

### **Antidepressant activity**

The results of the forced swim test and the tail suspension test showed considerable antidepressant potential after administration of *Musa paradisiaca* fruit paste (5%, 10%, and 20% w/w once daily for 15 days in a succession). These results were given by Parle and Malik. Anticonvulsants such as baclofen (10 mg/kg, intraperitoneally), prazosin (62.5 mg/kg, intraperitoneally), and p-CPA (100 mg/kg, intraperitoneally) were shown to considerably prevent this reduction in immobility time. In addition, the levels of monoamine oxidase and malondialdehyde were significantly decreased with the utilisation of a paste prepared from *Musa paradisiaca*<sup>[44]</sup>. Based on these findings, it is likely that the anti-depressant capability of the banana fruit is connected to the fruit's anti-oxidant, proadrenergic, pro-serotonergic, and/or Monoamine oxidase inhibitory activity. When administered to rats for a period of 14 days, the hydroalcoholic extract of *Musa paradisiaca* fruit demonstrated a significant reduction in the amount of time spent immobile during both the forced swim test and the tail suspension test. Darji and Galani used dosages of 250 and 500 mg/kg, orally. The antidepressant effects of the fruit extract were lessened when haloperidol was administered (0.1 mg/kg, i.p.), but increased when bromocriptine mesylate was administered (2 mg/kg, i.p.). Following treatment with fruit extract for 14 days, neurochemical testing revealed increased levels of the neurotransmitters norepinephrine, dopamine, and serotonin in the patient's system<sup>[45]</sup>.

### **Antidiarrhoeal activity**

The antidiarrheal effects of *M. paradisiaca* sap were first observed in rat models of castor oil-induced diarrhoea, enteropooling, and gastrointestinal motility by Yakubu et al (0.25, 0.50, and 1.00ml). The sap significantly slowed the beginning of diarrhoea, reduced the number of bowel movements, the fresh weight of faeces, and the water content of faeces, and enhanced the inhibition of bowel movements. Additionally, the sap reduced the amount of water content in faeces<sup>[46]</sup>. It is possible that alkaloids, phenolics, flavonoids, and/or saponins contribute to the antidiarrheal effect of *Musa paradisiaca* sap by, for example, promoting fluid and electrolyte absorption via de novo synthesis of the sodium potassium ATPase and/or decreasing nitric oxide levels. Another possibility is that the sap contains all of these active ingredients<sup>[47]</sup>. Arias et al. reported the antidiarrheal activity of a solution that contained 50 g/l of plantain flour and 3.5 g/l of sodium chloride. The experiment was conducted in a clinical setting with the purpose of rehydrating children who were suffering from acute diarrheal diseases. Banana flakes were found to be an efficient and effective treatment for diarrhoea in a clinical investigation conducted and reported by Emery et al. Bananas may be helpful in stopping diarrhoea since they contain pectin<sup>[48]</sup>.

### **Antiulcerative activity**

Elango et al. studied the antiulcer activity of the Siddha medication ripe fruit *Musa paradisiaca* bhasma by utilising a model of acute ulceration caused by an ethanol concentration of 80% and a model of chronic ulceration caused by an acetic acid concentration of 10% in rats<sup>[49]</sup>. In the acute model, bhasma was administered orally at doses of 10 and 20 mg/kg one hour prior to ulcer induction. In the chronic model, bhasma was administered once daily for a period of ten days. The bhasma appears to be effective as an antiulcer agent, as evidenced by both a decrease in the ulcer index and an increase in the amount of mucin present in the sample. In addition to catalase and superoxide dismutase testing, lipid peroxidation assays found evidence of antioxidant action. On an indomethacin-induced peptic ulcer, Herbert et al. investigated the cytoprotective effects of a *Musa paradisiaca*

methanol extract in conjunction with catecholamines. Following the application of the pylorus ligation procedure, it was discovered that the extract possessed cytoprotective and antisecretory properties<sup>[50]</sup>. The cytoprotective effects of the methanol extract of *Musa paradisiaca* against the ulceration caused by indomethacin have been established.

### Anticancer activity

Cancer, also referred to as a tumour or malignancy, is one of the numerous types of diseases that are responsible for the slow and painful deaths of individuals all over the world. As a consequence of this, researchers have taken an increased interest in the hunt for plants that have the potential to inhibit the growth of cancer cells in humans in the future. Researchers have investigated the anticancer effects of a wide variety of valuable plants, including the banana. Dietary variables, in particular a deficiency in dietary fibre and antioxidants, have been associated to the development of some malignancies, including colorectal cancer (CRC)<sup>[51]</sup>. Dietary fibre and antioxidants are increasingly becoming recognised as two of the most important factors in the management and prevention of colon cancer. In this regard, a primary study was carried out to screen various residues in agro-industries, and it was found that plantain inflorescence (PI) was an excellent source of dietary fibre and antioxidants. This led to the conclusion that PI might be used as a potential replacement for other residues. Using HT29 colon cancer cells, the researchers aimed to validate the anticancer activity of PI extracted with methanol (PIMET) and describe the many processes by which this effect is formed<sup>[52]</sup>. Specifically, the researchers were interested in how PIMET produces its anticancer effect. Colorimetric assays for cytotoxicity, including the 3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide (MTT) assay and the lactate dehydrogenase (LDH) release assay, were used to assess PIMET's cytotoxic effects (CE). These tests were carried out to see if PIMET was harmful to cells<sup>[53]</sup>. MTT is degraded by the mitochondria- and cytosol-based enzymes succinate dehydrogenase (SDH) and nicotinamide adenine dinucleotide (NADH) and nicotinamide adenine dinucleotide phosphate (NADPH), respectively<sup>[54]</sup>. Because of this, the only factor that is able to lessen the concentration of MTT is the number of live cells. The LDH release assay, on the other hand, is predicated on the observation that cells whose membranes have been damaged secrete cytosolic LDH into the media that surrounds them<sup>[55]</sup>. According to the findings of the MTT assay, the PI extracts all had different CE values against HT29 cells, although the methanol extract had the highest value. All of the extracts showed concentration-dependent increases in CE, while PIMET displayed the most cytotoxic activity by decreasing cell growth by a factor of 50% compared to the other extracts. The results of an LDH release assay corroborate these observations. The results of the MTT experiment demonstrated that an increased concentration of PIMET significantly affected the viability of HT 29 colon cancer cells while maintaining their membrane integrity<sup>[56]</sup>. According to the findings of the research, PIMET has a significant amount of several micronutrients, such as polyphenols, gallic acid, catechol, syringic acid, and ferulic acid. Because phenolic chemicals have been demonstrated to have an anticancer impact against cancer cells, this finding may help to explain why PIMET treatment resulted to a reduction in the number of HT29 colon cancer cells. As In addition, the anticancer effects of gallic acid, catechol, syringic acid, and ferulic acid have been demonstrated for certain cancer cell lines in the past<sup>[57]</sup>. When PIMET is present, there is a tendency for there to be shifts in the pattern of cell division (cell cycle). Typically, normal cells will turn into cancer cells if the proteins that are necessary for the cell division cycle are unable to properly progress from one phase of the cell cycle to the next. Cancer is a disease that affects the body's cells. Cancer cells multiply at a rate that is far higher than the normal rate of replication, which is tightly controlled within the confines of the cell division cycle<sup>[58]</sup>. Cancer cells also divide at an abnormally rapid rate. When the concentration of PIMET increased, different patterns of cell dispersion were seen throughout all 1094 samples. Gaining an understanding of the pathophysiology that lies beneath atherosclerosis. There are three phases of the HT29 gene. G2/M cells increased, however the number of G0/G1 cells significantly decreased. On the other hand, HT29 cells entered the G2/M phase with increased numbers after being treated with PIMET. In a similar vein, HT29 cell proteomics demonstrated that treatment with PIMET brought about alterations in the expression of a variety of proteins<sup>[59]</sup>. When the levels of the proteins peroxiredoxin-6 (PRDX6) and solute carrier (SLC) were lowered in HT29 cells, the result was a disruption in the normal activity of the mitochondria and a significant decrease in the cells' resistance to stress. In addition, levels of the protein known as inhibitor of apoptosis, or IAP3, were reduced, which caused HT29 cells to undergo apoptosis. Bananas were found to have more antioxidants, phenols, and anti-proliferative effect than several other

common fruits. This included cranberry, apple, red grape, strawberry, pineapple, peach, lemon, orange, pear, and grapefruit. Total antioxidant activity was evaluated by assessing the ability to scavenge oxyradicals and solid-phase extraction and base digestion were used to achieve this. The results of this study were published in (Hep G2). It was hypothesised that the capacity of bananas to preferentially target and inhibit the proteasome in Hep G2 is at least partially responsible for the anticancer activity of bananas. These data formed the basis for this hypothesis<sup>[60]</sup>. According to the findings of a recent study, those who eat bananas on a daily basis had a reduced risk of getting renal cell carcinoma, the most common form of kidney cancer. In addition, the administration of a methanolic extract of banana peel prevented testosterone from inducing regrowth of the ventral prostate gland and seminal vesicles in male mice that had been castrated. These mice were used to study the effects of castration (MEBP). This offered further evidence that MEBP is capable of inhibiting 5alpha-reductase, indicating that it has the potential to be helpful in the treatment of benign prostatic enlargement (BPH)<sup>[61]</sup>. Through the use of micronucleus assays (MN) and single-cell gel electrophoresis, it was discovered that the fruit and peel extract of *Musa paradisiaca* was mutagenic in the erythrocytes, leukocytes, and platelets of Swiss albino mice (SCGE). According to the findings of several studies, eating bananas is associated with a reduced risk of developing breast cancer<sup>[62]</sup>.

### Analgesic activity

The analgesic qualities of an aqueous extract of the plant were investigated using the hot plate method and the writhing test in mice. The acetic acid induced writhing method is helpful for identifying analgesics that function on the peripheral nervous system, whereas the hot plate approach is helpful for discovering analgesics that work on the central nervous system<sup>[63-65]</sup>. Analgesia can be achieved by inducing writhing syndrome with acetic acid because this process causes the body to release endogenous substances that are responsible for stimulating the pain nerve endings<sup>[66]</sup>. The dose-dependent analgesic effects of the aqueous extract of *Musa paradisiaca* suggest the presence of two components, one working centrally and the other acting via the peripheral pathway. The fact that an aqueous extract of the leaves of *Musa paradisiaca* contains carbohydrates, sterols, proteins, flavonoids, and alkaloids raises the possibility that these phytoconstituents are to blame for the remarkable activity of the plant<sup>[67]</sup>.

### Conclusion

In this article, we will examine the pharmacological qualities as well as the phytochemical make-up of *Musa*, namely *Musa paradisiaca*. The pharmacological studies that were looked at suggest that the traditional usage of the plant for treating conditions such as diarrhoea, ulcers, diabetes, hypertension, and cardiovascular disorders have some basis in truth. However, there have not yet been any clinical tests conducted on humans that could verify the usefulness of the plant in people. Nevertheless, we still have access to a variety of other paths that could lead us to the plant's latent capabilities. Isolating the bioactive component (or components) is also an essential step, as is investigating the prospect of doing additional *in vivo* studies in order to validate the claims and look into the generation of leads that could be helpful in the process of developing a pharmaceutical.

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