Characterization of medicinal properties of, *Musa acuminata* (Dwarf Cavendish) to ascertain therapeutic potential and its application

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Abstract

Bananas are considered to be fulfilling fruits in terms of nutrition and flavor. Banana is a very common part of people's diets across the world. Banana-based food products and supplements have been considered to be of high-quality delicacies. Musa acuminata, also commonly known as Matti in south Tamil Nadu, is a highly nutritious part of regular diet of people. Bananas are rich in carbohydrates, vitamins, proteins, amino acids and dietary fibres that directly benefit the bodily immune mechanisms. The driving force of this research is characterizing the phytochemical profile and the anti-cancer benefits associated with it. Semi-ripe bananas were chosen for this study and studied carefully to discern their therapeutic potential. Bananas are very rich in fibre and help to improve digestion and the digestive tract to alleviate constipation issues.

Also, through the enriched fibre quality in the banana, it has the potential to aid as a dietary supplement that can reduce the number of calories, which directly supports weight loss. Bananas, in general, are also found to contain antioxidants that can improve skincare and the bodily immune mechanisms. In this context, we present this idea to discern and ascertain the therapeutic ability of components of matti in treating liver cancer. Overall, our project aims to shed light on the significance of banana-based dietary supplements and their health benefits.

Keywords: *Musa acuminata*, phytochemical, therapeutic potential, matti.

Introduction

Bananas are a widely known food crop. The fruit is popularly consumed raw and is used for preparing various desserts. *Musa acuminata* Dwarf Cavendish (Matti banana), a South Asian native variety referred is an herbaceous plant but not a tree. Seeds of *Musa acuminata* can be diploid, triploid, or even seedless in fruits produced by parthenocarpy. It typically takes about 3–4 months for a flower to develop into fruit; the process of ripening is faster at the base when compared against the tip[2].

Generally, fruits are known to fulfil several dietary and nutritional requirements. They are enriched with carbohydrates, vitamins, crude proteins, amino acids and dietary fibres that have positive effect on the immune system, enhance cardiac health and aid with digestion. The *Musa acuminata* varieties are softer and more alkaline in nature, which can neutralise acidity in the gut[6]. The sample was sourced from Nagercoil, the southern part of Tamil Nadu, India.

The compound is extracted using methods that depend on the sample properties such as volatility, stability and solubility. The extraction using solvent method is preferred for its selective extraction, versatility, high efficiency, cost effectiveness and scalability[7]. In this study, peel compound extraction was done through solvent based extraction by simply immersing the sample in a suitable solvent. Solvent based extraction is used in compound extraction with the help of differential solubility, in which the solvent selectively dissolves the desired compounds and the unwanted compounds are left behind. Soxhlet extraction is a form of solvent extraction used for extracting compounds from a solid sample, which is preferred in case of fruit sample.

The solvent is heated using the heating mantle, which vaporises the solvent. The condenser condenses the vaporised solvent, allowing it to interact with the sample[8]. The process is repeated several times until efficient extraction of compounds is achieved. Phytochemical screening is a qualitative process through which the presence of bioactive compounds such as flavonoids, tannins, alkaloids, terpenoids, saponins and other phenolic compounds in a plant extract are detected[9].

Flavonoids are a vast group of phytochemicals known for their antimicrobial, antioxidant, anti-inflammatory and anticancer properties. Tannins come under the category of polyphenolic compounds which have been considered valuable in ancient medicine for their wound-healing, ant-inflammatory as well as antiviral properties[12]. Alkaloids are a category of compounds that contain nitrogen which is known to have several pharmacological activities. Terpenoids are bioactive compounds that were initially considered for their use in industries as fragrances and flavours. Later, they became significantly popular for its therapeutic properties[13].

Saponins, although having several biological benefits as a defence mechanism in plants, portray several benefits to human welfare such as aiding in cholesterol reduction, immune modulation, anti-inflammatory effect and digestive

health. The screening is carried out by conducting a series of qualitative chemical examinations that are formulated to detect compounds based on their reactivity.

This process determines the identity, properties and structure of compounds present in the sample. Techniques that are used for characterization are spectroscopic methods, chromatography techniques, mass spectrometry, microscopic methods and X-ray crystallographic methods. These techniques enable us to identify and to characterize the behaviour of the compounds. TLC is a technique used to detect and analyse the desired compound present in the mixture. This technique is based on differential migration and its affinity towards its stationary phase. RF (Retention Factor) is calculated by measuring the migration of compounds which is used to identify the compounds in the mixture. Mobile phase used in TLC varies in accordance to the properties of compound. TLC involves spotting a sample near the bottom of an adsorbent material on a thin, flat surface. The sample is then exposed to a solvent which moves up on thin layer via capillary action.

When solvent moves, it differentially carries the components available in the sample at varying rates, leading to the separation of components on the basis of their affinity to the adsorbent. GCMS (gas chromatography mass spectrometry) separates the sample based on different affinities towards stationary phase inside column. Inert gases like helium or nitrogen, are being utilized as mobile phase in this technique. Generally, stationary phase is either a liquid or solid coating inside the capillary column. Later in mass spectrometry, the isolated compounds get ionised and fragmented where they are detected based on their mass-to-charge ratio, resulting in a mass spectrum with unique properties for each compound.

HepG2 is a liver carcinoma cell line that was first isolated from a 15-year-old male in 1977. The cell line has been cultured and sub-cultured ever since. These cells are extensively researched as they exhibit various characteristics of human liver cells like their ability to metabolise chemicals and drugs, production of proteins distinct to liver and response to different toxins and hormones. HepG2 cell line is often used in the study of liver biology, disease modelling, disease progression and its response to a certain drug. The MTT assay stands for 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay[11]. It is essentially a colorimetric assay used to detect and measure the proliferation and viability of cells in a culture.

Material and Methods

Preparation of the sample: *Musa acuminata* (Dwarf cavendish) banana variety was acquired in Nagercoil from the southern part of Tamil Nadu and it weighed approximately 1 kilogram. Peel and fruit of the banana sample were separated. The fruit was chopped into small pieces to facilitate proper processing and evenly dried to remove moisture and separated peel was spread out in a tray to facilitate proper processing and evenly dried to remove moisture. Samples were sun-dried for a week, inspecting every two days for any contamination or fungus buildup. The contaminated pieces were segregated and discarded. Dried sample of fruit was milled to a fine powder and stored in an airtight container whereas the peel samples were stored separately.

Extraction: The compound extraction from the sample was performed using a Soxhlet apparatus. The sample powder weighing 250 grams was loaded in the thimble, below which the solvent was placed in a standard measuring flask[3]. The solvent used here was methanol. The solvent is heated using a heating mantle at 30°C which vaporises the sample. The vaporised sample is condensed with the help of a condenser, allowing it to fall back into the thimble where the sample is placed. This process was repeated several times until the compound was completely extracted from the sample.

The sun-dried peel was immersed in 1 litre of methanol in a 1500-ml standard measuring flask. The flask was tightly sealed with a cotton plug and muslin cloth. The sample was left to be extracted for over a week. Post-extraction, the immersed peel sample was filtered and the solvent containing the extracted compounds was stored in an airtight container for further processing.

Concentration: The extracted solvent sample was concentrated with the help of a rotary vacuum evaporator. Here, the extracted solvent is placed above a water bath of about 75°C, attached to a vacuum condensation system which helps to lower the boiling point of the solvent by creating a low pressure. The solvent is heated evenly by rotating the flask, which passes through the vacuum condenser. The separated solvent is collected separately. The concentrated liquid extract is left which can be used for further analysis.

Phytochemical assay: Eight clean test tubes were placed on a test tube stand and marked numerically from 1 to 8 respectively. 1 ml of concentrated extract was added to each test tube[5]. The phytochemical tests for qualitative analysis were carried out as follows:

Determination of alkaloids: To the sample, 1 ml of Dragendorff reagent was added. The formation of an orange-red precipitate indicates the presence of alkaloids while no colour change shows that the sample is devoid of alkaloids.

Determination of carbohydrates: 2-3 drops of Fehling's reagent (1, 2) were added to the sample and then heated in a hot water bath. A red precipitate indicates the presence of carbohydrates and if no such colour change is seen, then the sample does not contain carbohydrates.

Determination of glycosides: 3 ml of chloroform and 10% ammonium sulphate solution were added to the sample[10]. If the mixture turns pink, it confirms the presence of glycosides and vice versa.

Determination of saponins: To the sample, 2 ml of d.H_2O was added and mixed well. It is perceived that if foam formation occurs, it is more likely that saponins are present. Failure of foam formation indicates the absence of saponins.

Determination of protein content: To the sample, a drop of $CuSO_4$ solution, 95% ethanol and KOH pellets were added. A red or violet colour change indicates the presence of protein whereas no change in colour shows the absence of protein.

Determination of Amino Acid: 1 ml of ninhydrin reagent was added to the sample and heated in a warm water bath. The purple-blue colour change in the mixture confirms the presence of amino acids and vice versa.

Determination of Phenols: 1-2 drops of $FeCl_3$ solution were added to the sample. Formation of blue, green, red, or purple colours indicates the presence of phenols while failure to change colour shows the absence of phenols.

Determination of Triterpenoids: 2 ml of trichloroacetic acid was added to the sample[5]. The formation of a red precipitate indicates the presence of triterpenoids and the absence of triterpenoids is confirmed by a failure of colour change.

All of these procedures were repeated in sequential order for both samples respectively.

Column chromatography: Column chromatography was carried out. The column was packed using a solid adsorbent like silica gel in a cylindrical glass tube. The base of the column was fitted with a filter made of cotton or wool to fit the solid phase. The column was pre-eluted with the help of hexane to pack the silica gel column tightly. After the pre-elution, about 1g of the extracted sample was mixed with 1g of silica gel and loaded into the column. The column was eluted using various combinations of solvents, with a final volume of up to 20 ml. For the first fraction, 20 ml of hexane was taken. The second fraction consisted of hexane and ethyl acetate[14]. Ethyl acetate of 20 ml was used as the third fraction. The composition of the fourth fraction consisted of 15 ml of hexane and 5 ml of toluene. The fifth fraction consists of 10 ml of toluene and 10 ml of ethyl acetate.

Half and half of hexane and ethanol were taken for the sixth fraction. Similarly, toluene (10 ml) and ethanol (10 ml) were taken as the seventh fraction. Finally, the column was run with ethanol as the eighth fraction. The variants were collected separately to be analyzed. This step was carried out for both samples.

Thin-layer chromatography: A thin reference line around 0.5–1 cm above the bottom of the thin layer of chromatography paper was marked. The sample solution was applied repeatedly to the same spot over the reference line[17]. The chromatography chamber was prepared using six beakers marked 1 to 6 respectively and the solvent mixture was made up to a total volume of 4 ml. In the first beaker, ethyl acetate and toluene were added in a ratio of 3:1. The second beaker consists of ethyl acetate in a volume of 4 ml. In the third beaker, 4 ml of acetone was used as a solvent. Toluene and ethanol in a 2:1 ratio were taken in the fourth beaker. In the fifth beaker, hexane and ethanol were taken in equal parts. The sixth beaker consists of 4 ml of ethanol[16].

The spotted thin-layer chromatography papers were placed inside the different beakers in such a way that the reference line was slightly above the solvent line and the beakers were sealed tightly. Once the solvent reaches the top of the paper, it is carefully taken out and left to dry. The TLC paper was further visualised under UV light. The same process was repeated for all eight chromatography fractions of both samples.

Antioxidant assay: An assay was carried out to identify the antioxidant activity of the samples[1]. For this, 11 clean test tubes marked 1–11 numerically were taken. In the first 10 test tubes, samples of different concentrations ranging from 20µl to 200µl were added in such a way that 20µl of sample was increased in consecutive test tubes. All the test tubes were made to 1 ml using d.H_2O. To the final test tube, 1 ml of d.H_2O was added which was considered a control[5]. 300 µl of DPPH reagent were added to all 11 test tubes. Each mixture was viewed with a colorimeter at 550nm and the OD values were recorded[18]. An antioxidant activity test was performed on both samples. The percentage of inhibition was calculated using the formula:

$$\frac{Control\ OD - Sample\ OD}{Control\ OD} \times 100$$

GC-MS: Compound isolation was carried out with the help of GC-MS. In this method, the samples were injected separately into a gas chromatography column, where they were vaporised and the sample was separated based on size and its affinity towards the stationary phase[19]. The stationary phase is thinly coated inside the walls of the gas chromatography column. The mobile phase is an inert gas, commonly helium or nitrogen. The separated compounds were detected while passing through a mass-based detector. This resulted in the formation of multiple peaks on the chromatogram[20]. Each compound isolated was identified with the help of a standard reference library.

MTT assay: The MTT stands for 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay. The HepG2 cells were cultured in appropriate conditions and the cells were treated with an ethyl acetate fraction recovered from column chromatography[4]. The cells were now incubated at 37°C for 72 hours. 20µl of 2 mg/ml filter-sterilised MTT in phosphate saline buffer was introduced to each well and incubated for 3 hours at 37°C. Later, the MTT medium was removed and purple formazan crystals were solubilized in 100 µl of DMSO[21]. The absorbance was recorded at 540nm

with the help of a universal microplate reader. The percentage of inhibition was calculated using the formula:

$$\frac{Control\ OD - Sample\ OD}{Control\ OD} \times 100$$

Results were compared against the other untreated samples[15].

Results

Banana samples collected from Nagercoil, in the southern part of Tamil Nadu were chosen for this analysis. The bananas were collected at a semi-ripe stage for our study. The samples were split into fruit pulp and peel for their individual characterization. Qualitative phytochemical analysis was conducted on respective samples to discern the types of compounds present in them. The presence and absence of various bioactive compounds were confirmed through this analysis in both samples like alkaloids, flavonoids, terpenoids, glycosides, tannins and saponins.

Samples were then taken up for column chromatography. Purpose of the assay is to reduce the number of compounds present in the sample and to improve efficacy by choosing the most optimal fraction collected from column chromatography. All the fractions that were obtained were then further taken up to thin layer chromatography to identify the classes of compounds present in particular fractions. TLC was completed accordingly and the fractions selected for each sample were ethyl acetate (fruit) and toluene-ethanol (peel).

This selection was made according to their classes of compounds and after analysing their antioxidant properties. A significant amount of antioxidant activity was observed in all concentrations and the selected fractions of samples were analysed using GCMS. GCMS revealed the basic composition of the selected fractions and the fruit fraction contained 4'-Methoxy-5,7-dihydroxy isoflavone (Biochanin-A), oleic acid, n-Hexadecanoic acid (Palmitic acid), isopropyl stearate and phenol, 2,6-bis(1,1-dimethylethyl)-4-[(4-hydroxy-3,5-dimethylphenyl)methyl]- whereas the peel fraction contained 4H-1-Benzopyran-4-one, 5,7-dimethoxy-2-phenyl-, Phytol, 9,12,15-Octadecatrienoic acid, methyl ester, (Z,Z,Z)-, Indolo[2,3-c] quinolin-6(5H)-one, 7-benzyl-5-methyl- and Quinazolin-4(3h)-one, 3-(3-methoxyphenyl)-2-(2-phenylethenyl)-.

To discern therapeutic potential against liver cancer, both fractions were used on HepG2 cell lines and it was observed that in both fractions, the percentage of cell death kept increasing with increasing concentrations. However, the IC50 concentrations of the fruit and peel samples were calculated to be 152.99 µg/mL and 119.53 µg/mL respectively.

Fig. 1: Fruit sample collected for the analysis

Fig. 2: Peel sample collected for the analysis

Sample processing (Fruit)

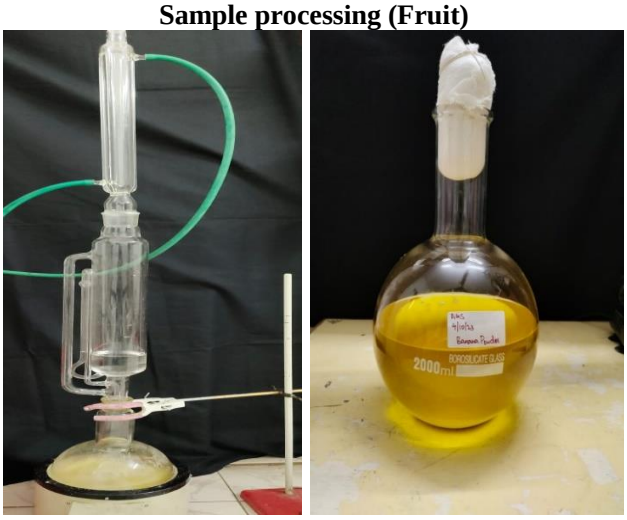


Fig. 3: Fruit sample prepared and processed for the analysis

Sample processing (Peel)

Fig. 4: Peel sample prepared and processed for the analysis

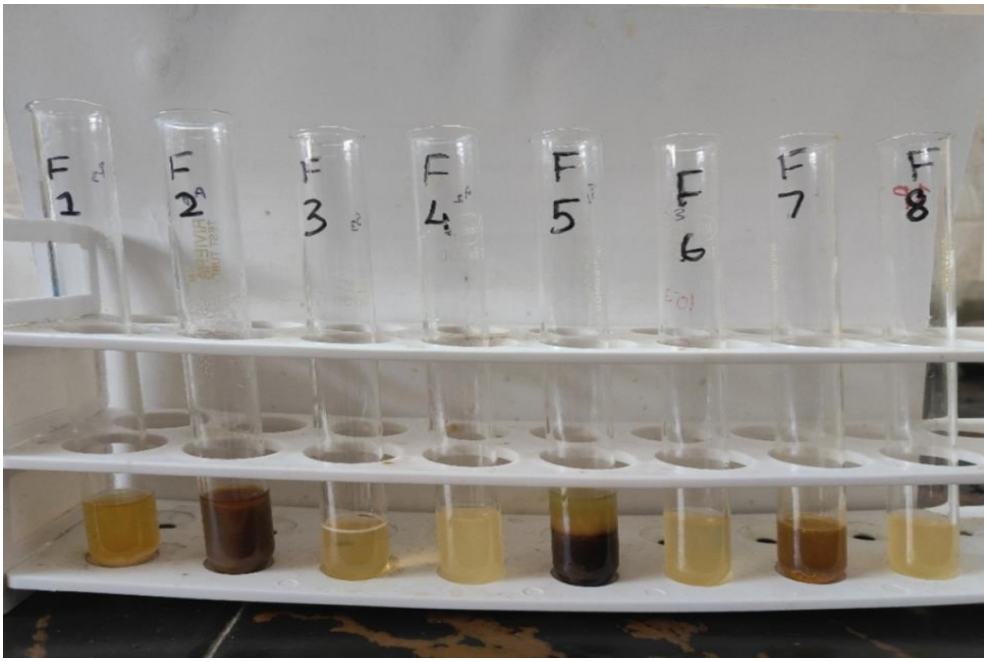


Fig. 5: Qualitative phytochemical analysis of fruit sample

Phytochemical Analysis (Peel)

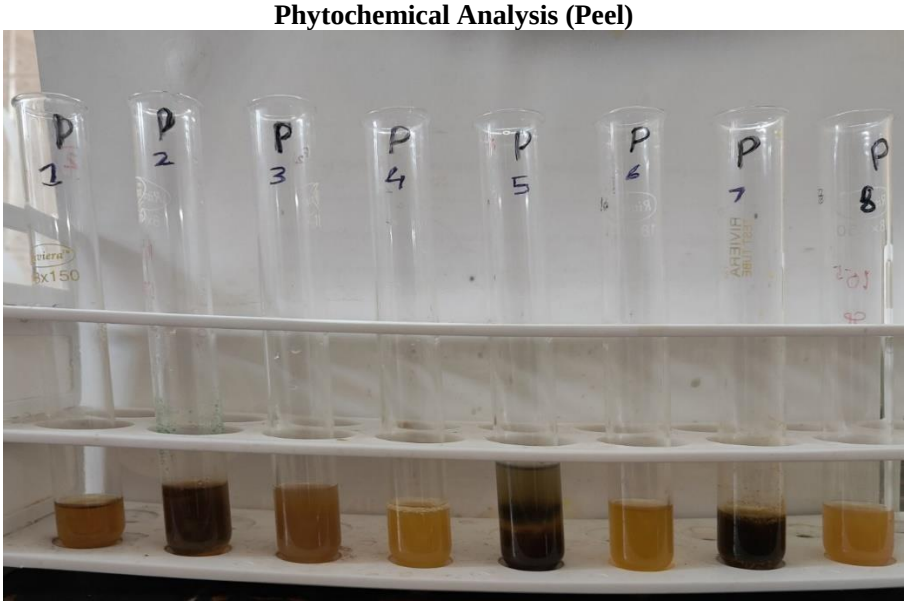


Fig. 6: Qualitative phytochemical analysis of peel sample

Table 1
Qualitative phytochemical analysis: Fruit and Peel sample

S.N.	Phytochemical test	Observation (Fruit)	Result (Fruit)	Observation (Peel)	Result (Peel)
1.	Test for Alkaloids	Formation of Orange-red precipitate	Presence of Alkaloids	Formation of Orange-red precipitate	Presence of Alkaloids
2.	Test for Carbohydrates	Formation of Red colour	Presence of carbohydrates	Formation of Red colour	Presence of carbohydrates
3.	Test for Glycosides	No formation of pink colour	Absence of Glycosides	No formation of pink colour	Absence of Glycosides
4.	Test for Saponins	No formation of foam	Absence of Saponins	Formation of foam	Presence of Saponins
5.	Test for Proteins	Formation of red or violet colour	Presence of Proteins	Formation of red or violet colour	Presence of Proteins
6.	Test for Amino acids	No formation of purple blue colour	Absence of Amino acids	No formation of purple blue colour	Absence of Amino acids
7.	Test for Phenols	Formation of blue, green, red, or purple colours	Presence of Phenols	Formation of blue, green, red, or purple colours	Presence of Phenols
8.	Test for Triterpenoids	No formation of red colour precipitate	Absence of Triterpenoids	No formation of red colour precipitate	Absence of Triterpenoids

Column Chromatography

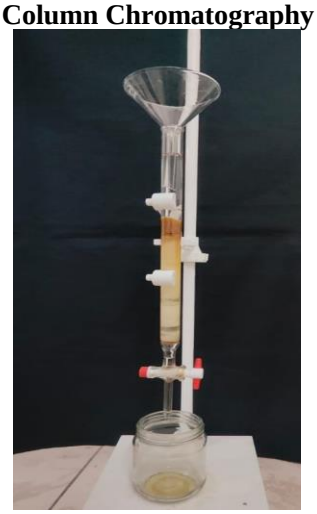


Fig. 7: Column chromatography analysis done to isolate fractions of samples

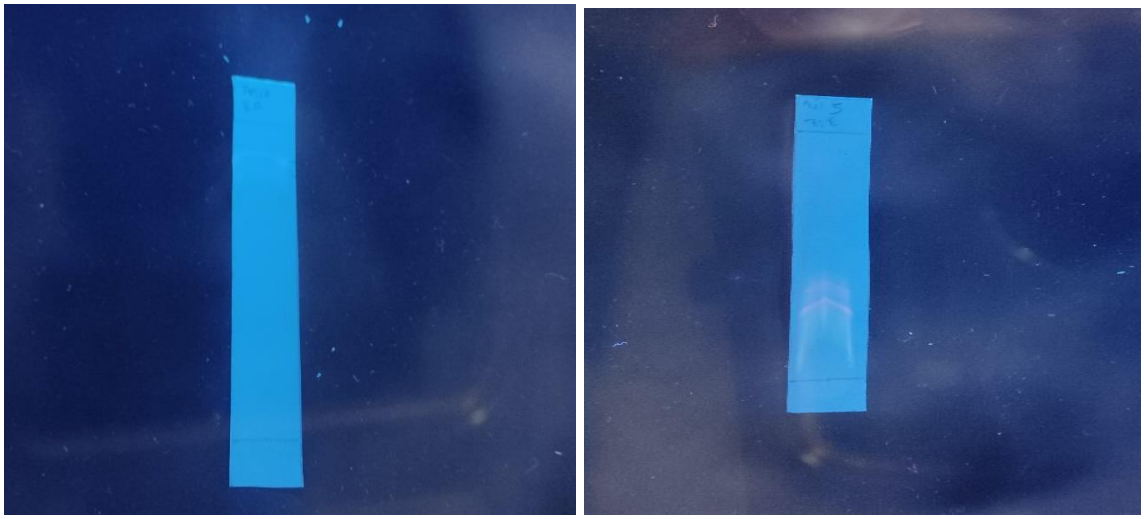


Fig. 8: TLC analysis of fruit and peel fractions isolated from column chromatography

Anti-oxidant activity

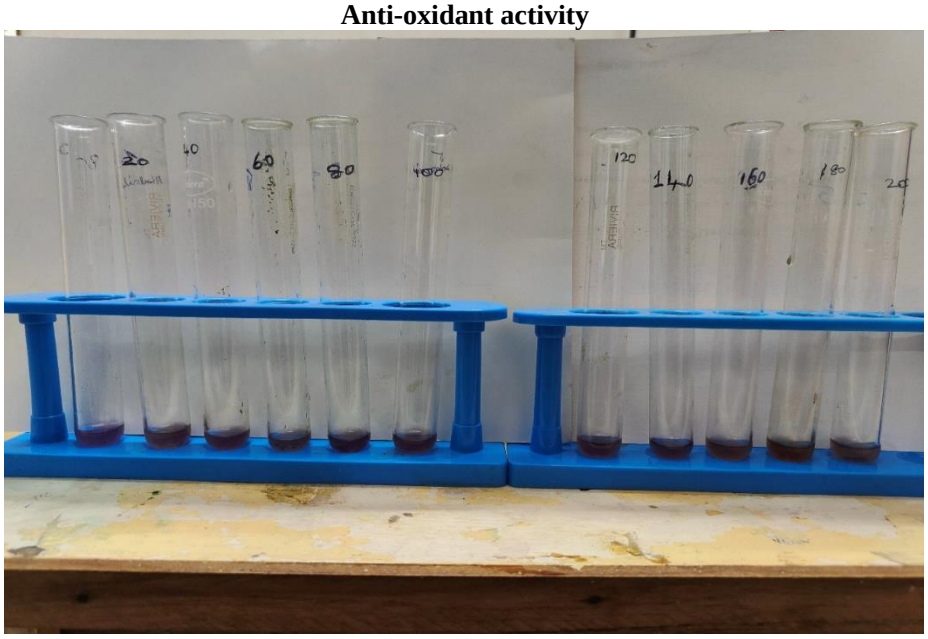


Fig. 9: DPPH-assay of *Musa acuminata* fruit fraction

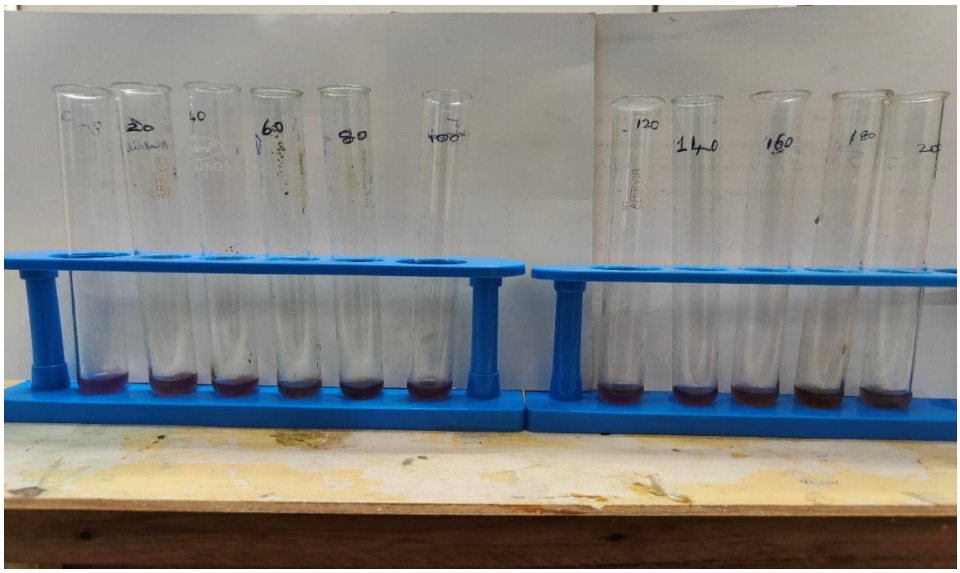


Fig. 10: DPPH-assay of *Musa acuminata* peel fraction

Table 2
DPPH-assay results of *Musa acuminata* fruit and peel fractions

Test tubes	Contents	Reagent	O.D values(Fruit)	Percentage of inhibition(Fruit)	O.D values(Peel)	Percentage of inhibition(Peel)
Control	1000µl d.H_2O	300µl	0.96	-	0.92	-
1	20µl sample + 980µl d.H_2O		0.80	16.6	0.88	4.3
2	40µl sample + 960µl d.H_2O		0.72	25	0.77	16.3
3	60µl sample + 940µl d.H_2O		0.63	34	0.62	36
4	80µl sample + 920µl d.H_2O		0.60	37.5	0.53	44.7
5	100µl sample + 900µl d.H_2O		0.52	45.8	0.45	53.1
6	120µl sample + 880µl d.H_2O		0.43	55.2	0.38	60.4
7	140µl sample + 860µl d.H_2O		0.35	63.5	0.31	67.7
8	160µl sample + 840µl d.H_2O		0.21	78	0.23	76
9	180µl sample + 820µl d.H_2O		0.16	83.3	0.18	81.2
10	200µl sample + 800µl d.H_2O		0.07	92.7	0.12	87.5

Percentage of inhibition

$$Percentage\ of\ inhibition = \frac{Control\ OD - Sample\ OD}{Control\ OD} \times 100$$

Percentage of inhibition (Fruit)

1st test tube = ((0.96 – 0.80)/ 0.96)*100 = 16.6%
2nd test tube = ((0.96 – 0.72)/0.96)*100 = 25%
3rd test tube = ((0.96 - 0.63)/0.96)*100 = 34%
4th test tube = ((0.96 – 0.60)/0.96)*100 = 37.5%
5th test tube = ((0.96 – 0.52)/0.96)*100 = 45.8%
6th test tube = ((0.96 – 0.43)/0.96)*100 = 55.2%
7th test tube = ((0.96 – 0.35)/0.96)*100 = 63.5%
8th test tube = ((0.96 – 0.21)/0.96)*100 = 78%
9th test tube = ((0.96 – 0.16)/0.96)*100 = 83.3%
10th test tube = ((0.96 – 0.07)/0.96)*100 = 92.7%

Percentage of inhibition (Peel)

1st test tube = ((0.96 – 0.88)/ 0.96)*100 = 4.3%
2nd test tube = ((0.96 – 0.77)/0.96)*100 = 16.3%
3rd test tube = ((0.96 - 0.62)/0.96)*100 = 36%
4th test tube = ((0.96 – 0.53)/0.96)*100 = 44.7%
5th test tube = ((0.96 – 0.45)/0.96)*100 = 53.1%
6th test tube = ((0.96 – 0.38)/0.96)*100 = 60.4%
7th test tube = ((0.96 – 0.31)/0.96)*100 = 67.7%
8th test tube = ((0.96 – 0.23)/0.96)*100 = 76%
9th test tube = ((0.96 – 0.18)/0.96)*100 = 81.2%
10th test tube = ((0.96 – 0.12)/0.96)*100 = 87.5%

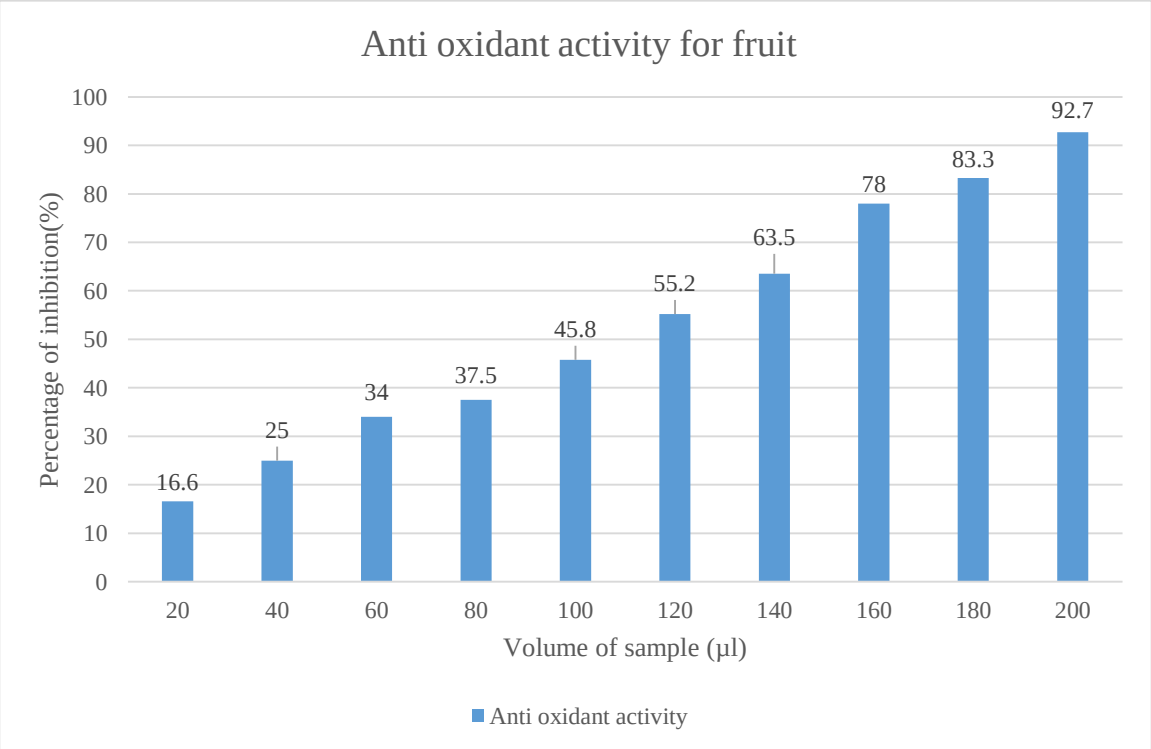


Fig. 11: DPPH-assay results graph of *Musa acuminata* fruit fraction

Anti-oxidant graph (Peel)

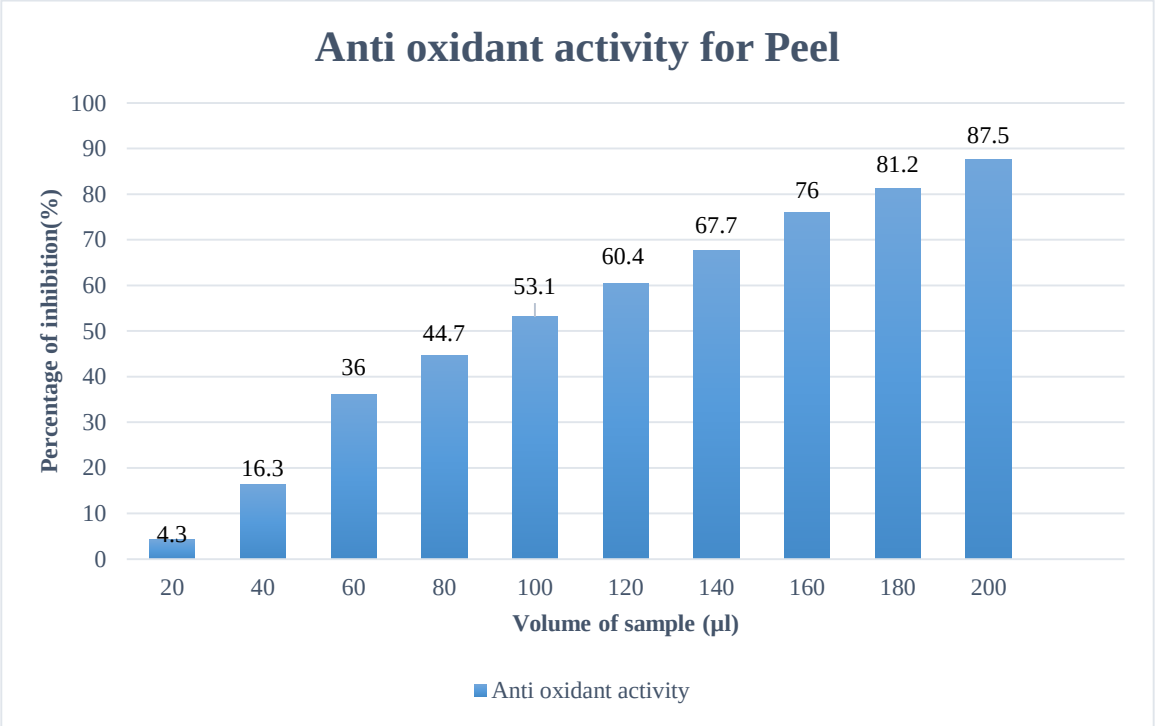
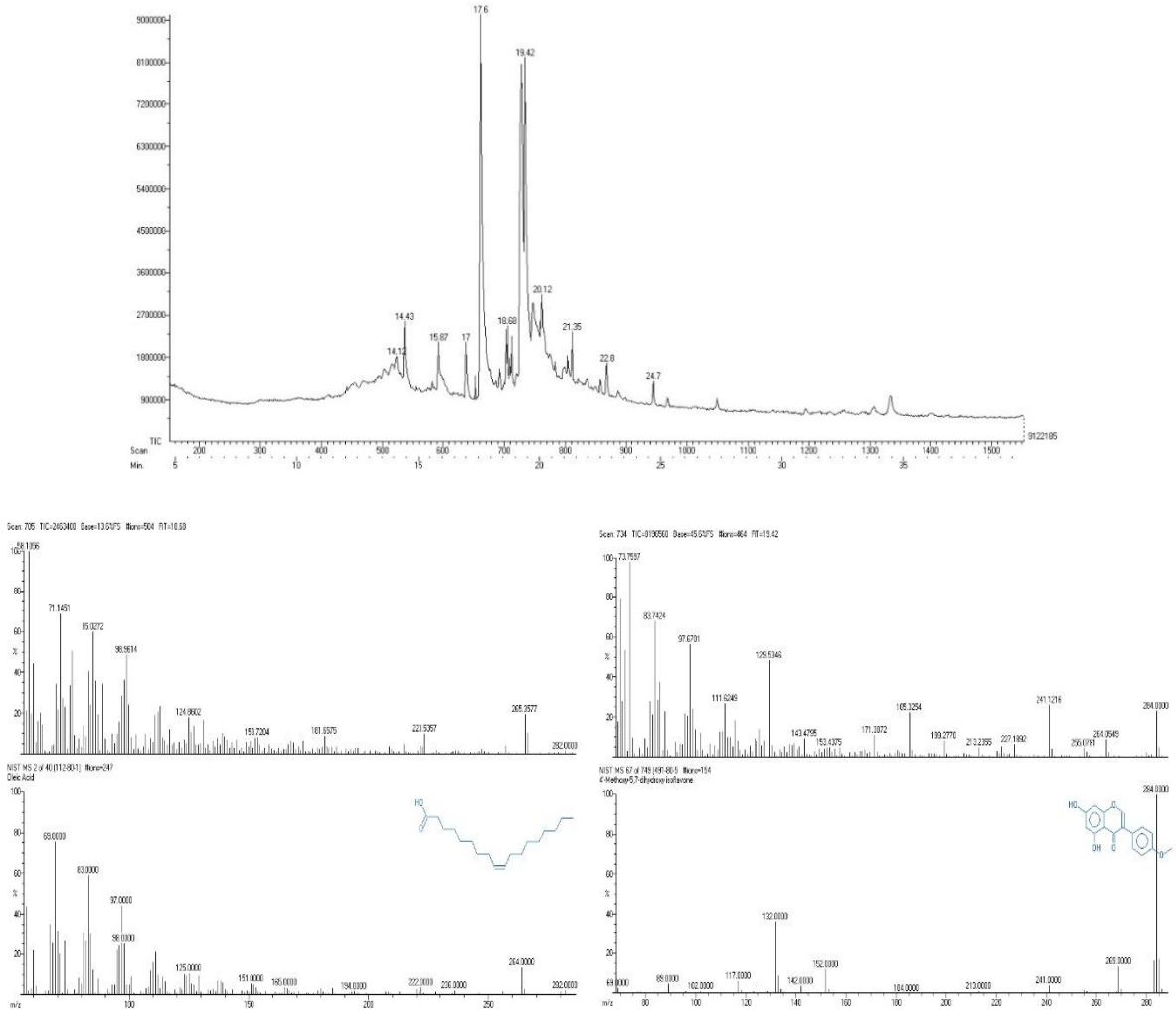


Fig. 12: DPPH-assay results graph of *Musa acuminata* peel fraction

GC-MS Graph (Fruit)



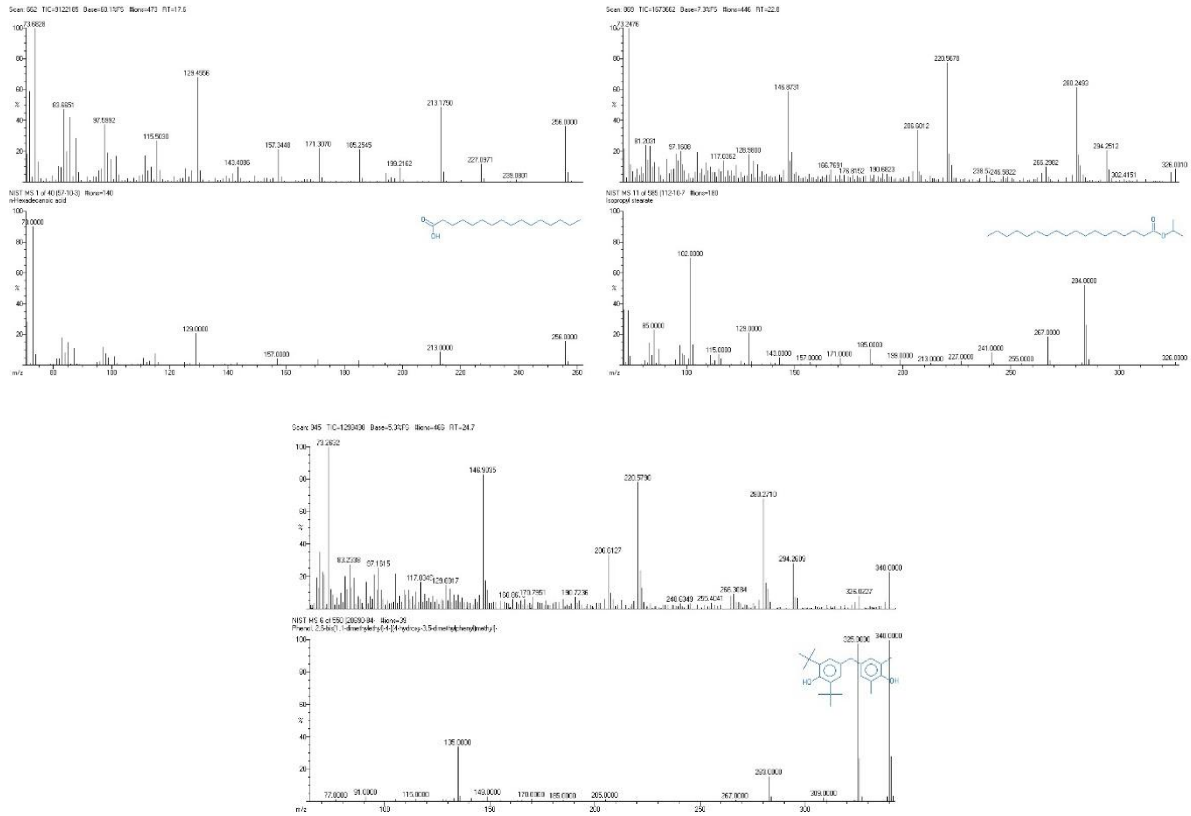
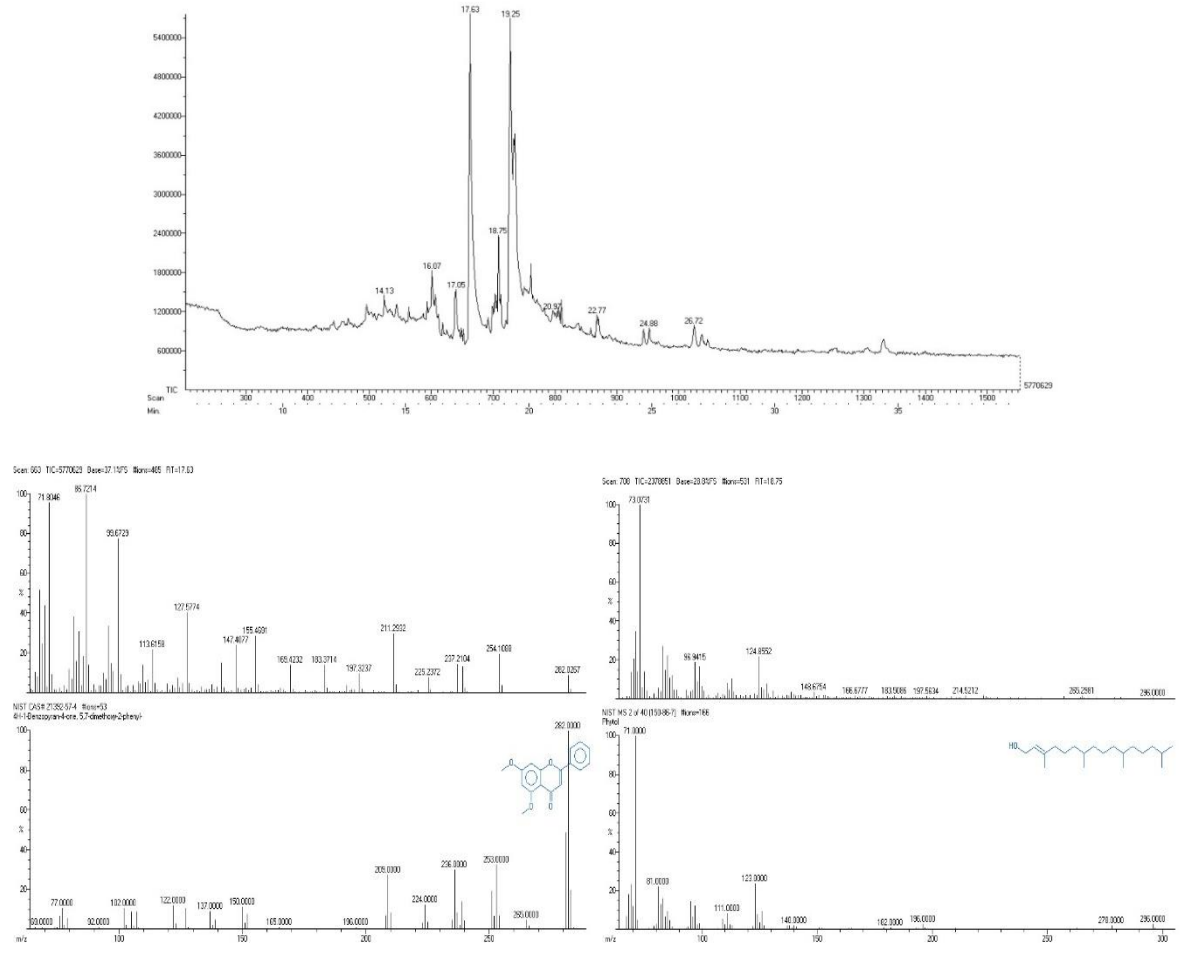


Fig. 13: GC-MS assay results graph of *Musa acuminata* fruit fraction

GC-MS graph (Peel)



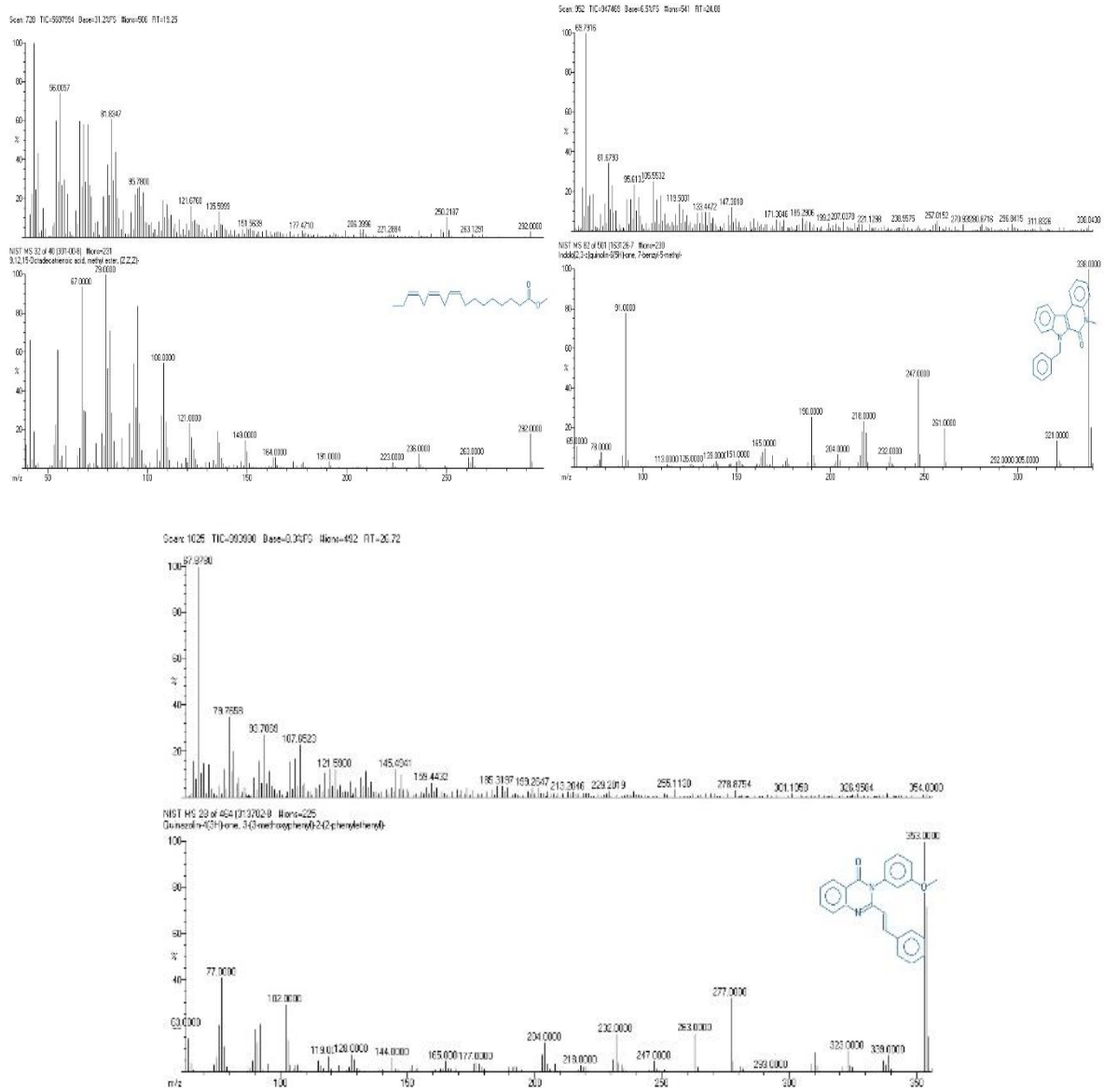


Fig. 14: GC-MS assay results graph of *Musa acuminata* peel fraction

Table 3
MTT assay results of *Musa acuminata* fruit and peel fraction

S.N.	Conc.(µg/mL)	PCD (Fruit)	IC 50 Conc.(Fruit)	PCD (Peel)	IC 50 Conc.(Peel)
1.	50	24.85	152.99 µg/mL	23.46	119.53 µg/mL
2.	100	43.92		41.83	
3.	150	49.02		52.16	
4.	200	59.61		65.66	
5.	250	67.63		72.81	
6.	300	74.01		78.14	

IC50 value (Fruit):
150µl = 49.02%
X = 50
X = (150*50)/49.02
X = 152.99µg/ml
IC50 value (Peel):
100µl = 41.83%
X = 50
X = (100*50)/41.83
X = 119.53µg/ml

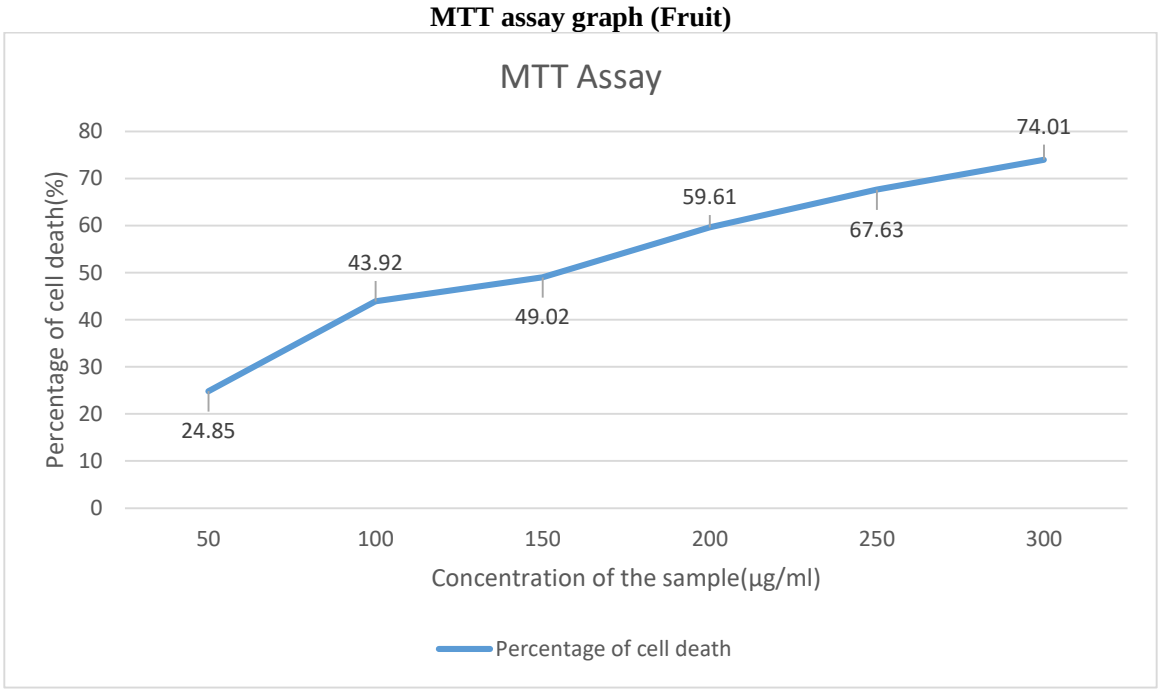


Fig. 15: MTT assay results graph of *Musa acuminata* fruit fraction

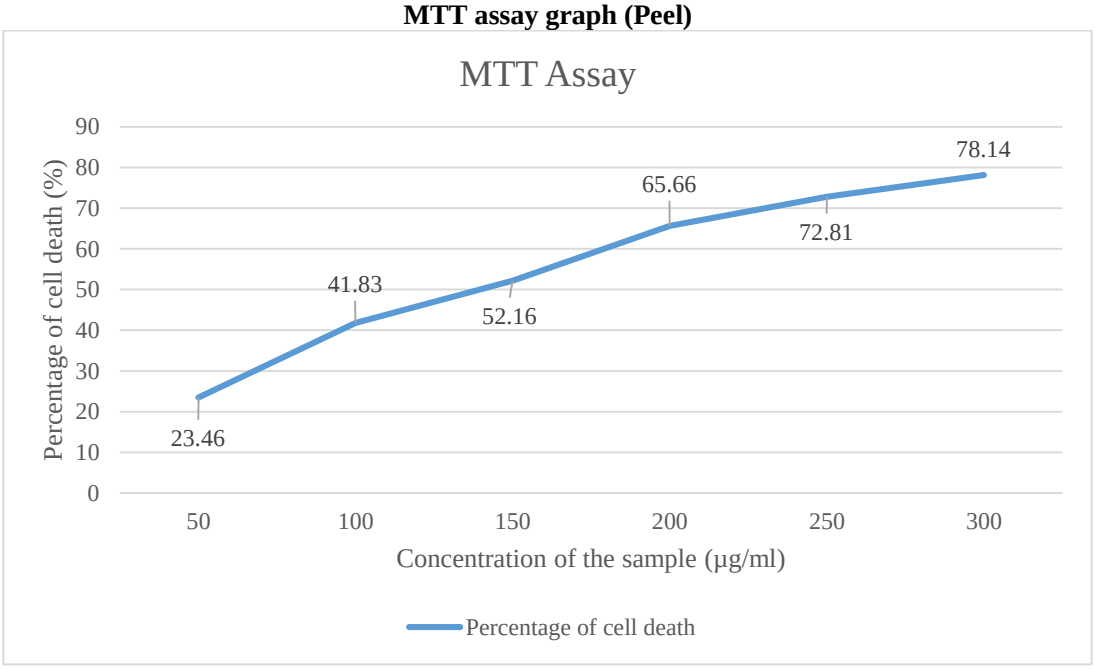


Fig. 16: MTT assay results graph of *Musa acuminata* peel fraction

Discussion

The qualitative phytochemical study of our sample revealed that the matti banana is a fulfilling fruit, comprising of all the basic nutrients. Apart from the primary nutrients, phytochemical screening conducted with the sample helped us detect that alkaloids were present in the sample which possessed several essential pharmacological properties and phenols, which exhibit miraculous properties like antioxidant, anti-inflammatory, antibacterial and anti-cancerous. Thin-layer chromatography detected the presence of biologically active compounds[22]. Further, our sample was analysed by carrying out column chromatography to purify and separate our sample into fractions acquired from column chromatography.

Furthermore, the fraction was analysed by GCMS to characterise the properties, behaviour and structure of compounds present in our fraction. The peaks produced were compared against the standard reference library. This revealed the presence of biochanin-A, oleic acid, palmitic acid and isopropyl stearate. Biochanin-A holds anticancer properties against myelomas by targeting CD-38 stem cell markers and altering the NF-KB and MAPK pathways. Oleic acid is regarded as highly effective in initiating apoptosis in

carcinogenic cells. Palmitic acid interacts with topoisomerase-1 to produce cytotoxic activity. Isopropyl stearate is rich in antioxidant properties which tend to protect skin from UV damage. The MTT assay was carried out with an ethyl acetate fraction of our sample to test the cytotoxicity of compounds present in our sample. The percentage of cell death was calculated using OD values[23]. The results proved the anticancer potential of the sample.

Conclusion

In conclusion, this study reveals the compounds and properties present in *Musa acuminata* (dwarf cavendish) aka Matti banana, a south Asian native variety, along with its therapeutic potential. The phytochemical screening of the fruit sample detected the presence of phenols, alkaloids and carbohydrates while the qualitative analysis of the peel sample detected the presence of phenols, saponins, proteins, alkaloids and carbohydrates. The presence of phenols and alkaloids indicates that both samples have compounds that are responsible for several therapeutic properties like antioxidant, anti-cancer and anti-inflammatory effects.

Further analysis was carried out to reveal the compound name, behaviour and characteristics through column chromatography, antioxidant assay, thin layer chromatography and GCMS. The compounds identified in the fruit sample were palmitic acid, oleic acid and isopropyl stearate and the compounds present in the peel sample were 5,7-dimethoxyflavone, phytol and linolenic acid methyl ester. To determine the extent of its pharmacological potential, an MTT assay was carried out. Upon interpretation of the results acquired from both samples, the compounds can be used as a potential anticancer drug as their cell cytotoxicity increases with the increase in compound concentration[24]. With precise formulation of dose in moderation, the desired level of cytotoxicity can be achieved. This particular variety of banana is native to the southern part of Tamil Nadu, India and this study aims to emphasise the importance of increasing research on native resources available in our country.

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