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Comparative Study of Different Parts of Fruits of Musa *Sp.* on the Basis of their Antioxidant Activity

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ABSTRACT

The purpose of the present study was to investigate the comparative antioxidant activity between the different parts of banana fruits of Musa sp. (Musa paradisiacal and Musa acuminata). Antioxidant activity was determined by electron transfer assay (ET assay) consisting of total Flavonoid content (Thin Layer chromatography and Aluminium chloride colorimetric method), total Phenolic content (Folin ciocalteau method), reducing power and DPPH free radical scavenging assay in alcoholic extracts of peel and pulp of ripe & uniripe of banana fruits of Musa sp. (Musa paradisiaca and Musa acuminata). This was found from the present study that from the thin layer of chromatography, Flavonoid glycoside and Anthocyanidins & anthocyanins found to be present in the ethanolic and methanolic extracts of them. Maximum flavonoid content found to be present in the methanolic extract of pulp of unripe banana fruit of Musa paradisiaca i.e. 90.56 mg QE/ g of Extract, whereas same amount of flavonoids to be present in the ethanolic extract of pulp of ripe of banana fruit of Musa acuminata by aluminium chloride colorimetric method. Total phenolic content was also determined in the ethanolic and methanolic extract of peel and pulp of ripe and unripe banana fruit of Musa sp., where 2298 mg QE/ g of extract found to be present in the ethanolic extract of pulp of unripe banana fruit of Musa paradisiaca. As far as methanolic extract was concerned, peel of ripe of banana fruit of Musa acuminata has also shown maximum phenolic content i.e. 1162 mg QE/ g of Extract. Antioxidant activity was als found to be maximum in the pulp of unripe banana fruit of Musa paradisiaca with percentage inhibition of i.e. 70.2%, where as 85.38% of inhibition found to be present in the pulp of unripe of Musa acuminata. Reducing power found to be maximum in ethanolic ripe pulp of Musa acuminata and also in methanolic ripe peel of Musa paradisiaca. We authors would like to conclude from the above study, unripe pulp and peel of Musa acuminata has shown maximum antioxidant and also the presence of polyphenolic flavonoids. Future work includes the purification and quantification of secondary metabolites to use as a where Unripe pulp and peel of Musa acuminata and Musa paradisiaca traditional herbal remedy.

Keywords: Total Flavonoid Content, Total Phenolic Content, DPPH Free radical Scavenging, Banana

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INTRODUCTION

Since antiquity to present day medicinal plants are frequently used traditionally to treat various diseases around the globe. Generation to generation the knowledge of medicinal plants to treat different diseases is passed down across the world which has contributed in the development of different systems of medicines and in exploration of their various scientific uses. Banana is one of those oldest plants which are found basically in the tropical world but now

spread all over the world. It is possibly the world's oldest cultivated crop. In India banana is considered holiest plant and is spread all over India. *Musa paradisiaca* and *Musa acuminata*, two most common species found in india which is not only delicious in taste but also rich in dietary supplements like vitamins, minerals and carbohydrates. Banana plant parts like leaves, flower, roots are also used to treat different diseases. Bananas are good sources of essential nutrients like potassium and sodium that helps to maintain proper fluids balance in our body. *Musa paradisiaca* is a herbaceous plant which grows up to 9 m long, fruits are oblong, fleshy, 5-7cm long in wild form and longer in the cultivated varieties. *Musa acuminata* is a treelike herb that grows 5 - 9 m in height. The ripe fruits is sweet, juicy and full of seeds and the peel is thicker than other banana.The fruit of *Musa paradisiaca* and *Musa acuminata* since ancient age have been used to treat abdominal distress such as constipation, diarrhoea (unripe), dysentery, intestinal lesions, unripe banana also used in curing diabetes , in uremia, nephritis, gout, hypertension, cardiac disease [1]. *M. spaientum* is used to control excessive menstruation in females[2]. Banana leaves heat dried converted into ashes can beused in eczema [3], and also as cool dressings for blister and burns [4].

Variety of banana fruit peels over the decades has gained attention as the natural sources of antioxidants and phytochemical content which comprises of compounds with free radical scavenging activity. Dopamine, serotonin,Catecholamines such as norepinephrine [5, 6], tryptophan, indole compounds [7], pectin have been found in the pulp of banana. Several flavonoids and related compounds (Leucocyanidin, quercetin and its galactoside) were isolated from the unripe pulp of banana plantain [8]. Phytochemical screening of the various aqueous, ethanolic, methanolic extracts of the banana peel and pulp has revealed the presence of secondary metabolites like flavonoids, saponin, tannins, alkaloids, phenols. Besides some of well known secondary metabolites banana peel and pulp also persists antibacterial properties and anti bacterial peptides activity. The flavonoids that are found in the banana are responsible to reduce level of hydroperoxides and conjugated dienes by activating superoxide dismutase SOD and catalase.

This was observed from the previous studies that each and every part of plant consists of different secondary metabolites in them as well as their therapeutics activities. The purpose of the present research work was to investigate comparative study of antioxidant activity of different parts of banana fruits such as peel and pulp of ripe and unripe of Musa sp. and to find the associated secondary metabolites that were responsible for maximum antioxidant activity in them.

MATERIALS AND METHODS

1.1 Plant Samples

Fresh and healthy banana fruits, considering both Unripe and Ripe form, of two different Musa *sp.* i.e. *Musa paradisiaca* and *Musa acuminata* (Poovan) were collected from very well-known market of Okhala mandi and Vinod nagar, Delhi. Taxonomical identification was done by Dr. Ravi Kumar, R&D, Helix BioGenesis Pvt. Ltd., India. Bananas were then washed with distilled water to remove dirt and soil particles.

1.2 Preparation of extract

Aqueous and alcoholic extract of peel and pulp of ripe and unripe banana fruits of *Musa paradisiaca* and *Musa acuminata* were prepared by separating, washing, drying the peel and pulp of banana fruits where as pulp was cut into small pieces. Aqueous and alcoholic extract were prepared by taking 5g of dried pulp and peel of ripe and unripe of *Musa paradisiaca* and *Musa acuminata* and then dissolved in 50ml of distilled water to make aqueous extract. For alcoholic extract, organic solvents were used such as ethanol, methanol, acetone, n-hexane, chloroform, petroleum ether & ethyl acetate and it was allowed to boil at 100°C for 30min, where as for alcoholic extract they were allowed to boil at 85-90°C. Conical flasks of extracts were covered with cotton plugs to avoid evaporation. Extracts were placed in shaker for 24 hrs at 250rpm. After overnight shaking they were filtered with muslin cloths and then with filter paper twice. Extracts were stored at 4°C [9].

1.3 Preliminary Phytochemical screening

Phytochemical screening was done in order to determine the presence of secondary metabolites in the aqueous and alcoholic extracts of peel and pulp of ripe and unripe banana fruits of *Musa paradisiaca* and *Musa acuminata* [9]. To reveal the presence of saponins, tannins, flavonoids, terpenoids, napthoquinone, inulin, glycosides, reducing sugar, alkaloids and soluble phenols standardized protocol was used [9][10].

1.4 Determination of Flavonoids

1.4.1 Qualitative estimation by thin layer chromatography

TLC was performed on the 20 × 20 cm plates precoated with 0.2 mm layers of silica gel 60 F254 (Merck). Plates were allowed to backed for 1hr. Volume of 20µl standard Quercetin (1mglml) loaded along with same amount of aqueous and alcoholic extracts of peel and pulp of ripe and unripe banana fruits of *Musa paradisiaca* and *Musa acuminata*. Different mobile phase was run in order to determine the Flavonoid glycoside and Anthocyanidins & anthocyanins. For Flavonoid glycosides, mobile phase was ethyl acetate-methanol-water in the ratio of 50:3:10, where as for Anthocyanidins & anthocyanins, mobile phase was n-butanol-acetic acid-water in the ratio of 4:1:2. TLC plates were observed under UV illuminator after spraying with 10% $AlCl_3$ solution. Their Refractive index were measured [11] [12].

1.4.2 Quantification of flavonoids (Aluminium chloride colorimetric method)

To quantify the flavonoids into the defined extracts of peel and pulp of ripe and unripe banana fruits of *Musa paradisiaca* and *Musa acuminata* were determined by Aluminium chloride colorimetric method. Maceration extraction methods were used where filtered extracts were evaporated to dryness. 0.5ml of extracts of (1mg/ml) or Quercetin standard 10 to 100µg/ml), 1.5ml methanol, 0.1ml aluminium chloride (10%), 0.1ml of potassium acetate solution (1M) and 2.8ml of distilled water were added and mixed well. Sample blank was prepared by replacing aluminum chloride with distilled water and absorbance was measured at 417 nm. The standard calibration plot was made to determine the concentration of flavonoids in the extract. The concentrations of Flavonoid in the extracts were calculated from the calibration plot and were expressed in mg Quercetin Equivalent/g of extract [9].

1.5 Total Phenolic content

The total phenolic content of extracts was determined by Folin ciocalteau method. 0.5ml of extracts or Quercetin standard 10 to 100µg/ml) was taken and 0.1ml of Folin – Ciocalteu reagent (0.5N) was added into it and incubated at room temperature for 30min. 2.5ml of 20% saturated sodium carbonate is added in to the solution and further incubated for 30min. After incubation the absorbance was measured at 760nm against the blank reagent. . The standard calibration plot was made to determine the concentration of phenolic component in the extract. The concentrations of phenolic component in the extracts were calculated from the calibration plot and were expressed in mg Quercetin Equivalent of phenol/g of extract.

1.6 Antioxidant activity

1.6.1 DPPH Free Radical Scavenging

The antioxidant activity of each extracts of banana peel and pulp of ripe and unripe was measured in terms of hydrogen donating or radical scavenging ability by using the stable radical DPPH (1, 1-diphenyl-2 picrylhydrazyl). Experiments were performed out according to the standardized protocol [13]. 3.8ml of methanol was taken as blank, where as 3ml of methanol added in0.3ml of 0.4 mM DPPH solution was taken as control. Reaction mixture was prepared by taking 3ml of methanol mixed well with 0.5 mL of aqueous & alcoholic extracts and 0.3ml of 0.4 mM DPPH solution. Solution such as blank, control and reaction mixture were allowed to incubate in the dark for 30 min. The colour of the reaction mixture fades as compared to the control and the reduction is observed by the decrease in the absorbance at 517 nm. The results were expressed in percentage of inhibition by using formula. The results were compared with the positive control i.e. standard Quercetin. The percentage inhibition of the DPPH radical was measured by using the following formula.

Percentage of inhibition = [(absorbance of control- absorbance of reaction mixture)/absorbance of control] X 100

1.6.2 Reducing power

Determination of reducing power was based on the involvement of transfer of electron. 0.1ml of aqueous and alcoholic extracts were mixed with 2.5ml of 0.2M phosphate buffer (pH 6.6) and 2.5ml of 1% potassium ferricyanide. After incubating the mixture at 50°C for 20min, 2.5ml of 10% trichloroacetic acid, 2.5ml of distilled water and 0.5ml of 0.1% ferric chloride solution were mixed well and then their absorbance were measured at 700nm against a blank. The blank consists of all reagents except the sample. Absorbance of mixture obtained in increasing indicates reducing power [14].

RESULTS

1.7 Preliminary Phytochemical Screening

From the above study it was found that, the phytochemical screening revealed the presence of secondary metabolites in the aqueous and alcoholic extracts of pulp and peel of ripe and unripe banana fruits of *Musa paradisiaca* and *Musa acuminata*. This was observed from the above study that ethanolic extract, methanolic extract, acetone extract and ethyl acetate extract has shown the presence of flavonoids in the ripe pulp of *Musa paradidiaca* as given in Table 1. These flavonoids were also found to be present in the ethanolic, acetone, and ethyl acetate extract of ripe peel of *Musa paradisiaca* as given in Table 2. Unripe pulp of *Musa paradisiaca* has also shown the presence of flavonoids in the aqueous and ethanolic extract in it as given in Table 3. Flavonoids were also found to be present in the aqueous, methanolic and acetone extract of unripe peel of *Musa paradisiaca* and ripe pulp of *Musa acuminatas* as given in Table 4 & 5. Aqueous, ethanolic and methanolic extract of ripe peel of *Musa acuminata* has shown the presence of flavanoids, where as methanolic extracts of unripe pulp of *Musa acuminata* as shown in Table 6-7. Flavonoids were also found to be present in the aqueous, ethanolic , methanolic and acetone extract of unripe peel of *Musa acuminata* as shown in Table 8.

1.8 Determination of flavonoids

Flavonoids were determined by both thin layer chromatography method as well as aluminum chloride colorimetric method in those extracts that has shown presence of flavonoids in the preliminary phytochemicals screening. Qualitative estimation was done by Thin layer chromatography by using different mobile phase. This was observed from the mobile phase i.e. ethyl acetate-methanol-water (50:3:10), flavonoid glycosides found to be present in the methanolic extract of ripe peel and pulp of *Musa paradisiaca* with an refractive index of 0.61 & 0.928, respectively, as shown in the Figure 1 whereas by using different mobile phase that is n-butanol-acetic acid-water (4:1:2) has revealed the presence of Anthocyanidins & anthocyanins with an refreactive index of 0.8 & 1.4, respectively as shown in Figure 3. Flavonoid glycosides was also found to be present in the methanolic extract of raw peel, methanolic extract of raw pulp, methanolic extract of ripe pulp, ethanolic extract of ripe pulp and ethanolic extract of ripe peel of *Musa acuminata* with an refractive index of 0.78, 0.642,0.785,0.642 and 0.607, respectively. Anthocyanidins & anthocyanins were also found to be present in the methanolic extract of ripe pulp and ethanolic extract of ripe pulp of *Musa acuminata*with refractive index of 1 and 0.68, respectively as shown in Figure 2-3.

Quantification of flavanoids was done by aluminium chloride colometric method. Total flavonoids content was determined in order to estimate the number of flavones in those extracts that has shown the presence of flavonoids in their defined extracts of pulp and peel of ripe and unripe banana fruits of *Musa paradisiaca* and *Musa acuminata*. By using a standard plot of quercetin i.e. y=0.007x+0.068, R^2=0.852 as shown in Graph 1. The flavonoid content has been expressed in mg QE/g of extracts. It was observed from the present study that Flavonoid found to maximum in both unripe pulp and ripe peel of banana fruit of *Musa paradisiaca* i.e.90.56 mg QE/g of extract in its methanolic extract, where as ethanolic extract of ripe pulp of banana fruit of *Musa acuminata* has shown maximum Flavonoid count i.e. 90.56 mg QE/g of extract as shown in Table 9 and 10.

1.9 Total Phenolic content

Phenolic compounds were determined by standardized protocol to determine the phenolic constitutents content was done in order to estimate the number of phenols in those extracts that has shown the presence of flavonoids in their defined extracts of pulp and peel of ripe and unripe banana of *Musa paradisiaca* and *Musa acuminata*. By using a standard plot of quercetin i.e. y=0.001x-0.015, R^2=0.962 as shown in Graph 2. The phenolic content has been expressed in mg QE/g of extracts. Total Phenolic content found to maximum in ethanolic extract of unripe peel of banana fruit of *Musa paradisiaca* i.e. 2298 mg QE/ g of extract, where as methanolic extract of ripe peel of banana fruit of *Musa acuminata* has shown 1168 mg QE/ g of extract as shown in Table 11 and 12.

1.10 Antioxidant activity

1.10.1 DPPH Free Radical Scavenging:

The total antioxidant capacity of different parts of banana fruit i.e. peel and pulp consisting unripe and ripe was determined by quantitative free radical scavenging assay on the basis of percentage inhibition. Whereas it has shown the maximum antioxidant activity found to be present in acetone extract of unripe peel and ripe pulp of *Musa paradisiaca* with percentage inhibition of 73.61% and 72.91%. As far as the antioxidant activity of *Musa acuminata* extracts was concerned, methanolic extract of unripe pulp has shown maximum antioxidant capacity i.e. 85.38% of inhibition as obtained from Graph 4 and 5.

1.10.2 Reducing power assay:

This was done in order to determine reducing power in the defined extracts that has shown the presence of Flavonoid as well as Phenolic component, which has reduction potential that react with potassium ferricyanide to form potassium ferrocyanide which then react with ferric chloride to form ferric ferrous complex that has maximum absorption at 700nm as given in Graph 3.

Table. 1: Preliminary phytochemical screening of aqueous and alcoholic extracts of Ripe Pulp of *Musa paradisiaca*

Phytochemical constituents	Aqueoues extract	Ethanol Extract	Methanol extract	Acetone extract	Chloroform extract	N-Hexane extract	Ethyl acetate extracts	Petroleum ether Extracts
Saponins	+	+	+	-	-	+	-	+
Tannins	+	+	+	+	-	-	-	-
Flavonoids	-	+ +	++	++	-	-	+	-
Terpenoids	-	+	+	-	-	-	-	-
Napthoquinone	+	-	-	-	-	-	-	-
Inulin	+	+	+	-	-	-	-	-
Glycosides	-	-	-	-	-	-	-	-
Reducing sugar	+	-	-	+	-	-	+	-
Alkaloids	+	+	+	-	+	++	+	-
Soluble phenols	-	+	+	+	-	-	-	-

Table. 2: Preliminary phytochemical screening of aqueous and alcoholic extracts of Ripe Peel of *Musa paradisiaca*

Phytochemical constituents	Aqueoues extract	Ethanol extract	Methanol extract	Acetone extract	Chloroform extract	N-Hexane extract	Ethyl acetate extracts	Petroleum ether extracts
Saponins	+	-	-	-	-	+	-	+
Tannins	+	+	+	+	+	-	+	-
Flavonoids	-	+ +	-	++	-	-	+	-
Terpenoids	+	+	-	+	-	-	+	-
Napthoquinone	+	-	-	-	-	-	-	-
Inulin	-	+	+	-	+	-	-	-
Glycosides	-	-	-	-	-	-	-	-
Reducing sugar	+	+	+	+	-	-	-	-
Alkaloids	+	+	+	+	+	+	+	-
Soluble phenols	-	-	+	+	-	-	-	-

Table. 3: Preliminary phytochemical screening of aqueous and alcoholic extracts of Unripe Pulp of *Musa paradisiaca*

Phytochemical constituents	Aqueous extract	Ethanolic extract	Methanolic extract	Acetone extract	Chloroform extract	N-Hexane extract	Ethyl acetate extracts	Petroleum ether extracts
Saponins	+	-	-	-	-	+	-	+
Tannins	+	+	+	+	+	-	-	-
Flavonoids	+	+	-	-	-	-	-	-
Terpenoids	+	+	+	-	-	-	-	-
Napthoquinone	-	-	-	-	-	-	-	-
Inulin	+	-	+	-	-	-	-	-
Glycosides	-	-	-	-	-	-	-	-
Reducing sugar	+	-	+	-	-	-	-	-
Alkaloids	-	+	+	+	-	+	+	-
Soluble phenols	+	+	+	-	-	-	-	-

Table. 4: Preliminary phytochemical screening of aqueous and alcoholic extracts of Unripe Peel of *Musa paradisiaca*

Phytochemical constituents	Aqueous extract	Ethanolic extract	Methanolic extract	Acetone extract	Chloroform extract	N-Hexane extract	Ethyl acetate extracts	Petroleum ether extracts
Saponins	-	-	-	-	-	+	-	+
Tannins	+	+	+	-	+	-	+	-
Flavonoids	+	-	+	+	-	-	-	-
Terpenoids	+	+	+	-	-	-	-	-
Napthoquinone	-	-	-	-	-	-	-	-
Inulin	+	-	-	-	-	-	-	-
Glycosides	-	-	-	-	-	-	-	-
Reducing sugar	-	-	+	-	-	-	-	-
Alkaloids	-	+	+	+	-	+	+	-
Soluble phenols	-	+	+	-	-	-	-	-

Table. 5: Preliminary phytochemical screening of aqueous and alcoholic extracts of Ripe Pulp of *Musa acuminata*

Phytochemical constituents	Aqueoues extract	Ethanolic extract	Methanolic extract	Acetone extract	Chloroform extract	N-Hexane extract	Ethyl acetate extracts	Petroleum ether extracts
Saponins	+	+	+	-	-	+	-	+
Tannins	+	+	+	+	-	-	-	-
Flavonoids	-	+ +	++	-	-	-	-	-
Terpenoids	-	+	+	-	-	-	-	-
Napthoquinone	+	-	-	-	-	-	-	-
Inulin	+	+	+	-	-	-	-	-
Glycosides	-	-	-	-	-	-	-	-
Reducing sugar	+	-	-	+	-	-	+	-
Alkaloids	+	+	+	-	+	++	+	-
Soluble phenols	-	+	+	+	-	-	-	-

Table. 6: Preliminary phytochemical screening of aqueous and alcoholic extracts of Ripe Peel of *Musa acuminata*

Phytochemical constituents	Aqueoues extract	Ethanolic extract	Methanolic extract	Acetone extract	Chloroform extract	N-Hexane extract	Ethyl acetate extracts	Petroleum ether extracts
Saponins	-	-	-	-	-	+	-	+
Tannins	+	+	+	+	+	-	+	-
Flavonoids	++	+ +	+	-	-	-	-	-
Terpenoids	+	+	-	+	-	-	+	-
Napthoquinone	+	-	-	-	-	-	-	-
Inulin	-	+	+	-	+	-	-	-
Glycosides	-	-	-	-	-	-	-	-
Reducing sugar	+	+	+	+	-	-	-	-
Alkaloids	+	+	+	+	+	+	+	-
Soluble phenols	-	-	+	+	-	-	-	-

Table. 7: Preliminary phytochemical screening of aqueous and alcoholic extracts of Unripe Pulp of *Musa acuminata*

Phytochemical constituents	Aqueoues extract	Ethanolic extract	Methanolic extract	Acetone extract	Chloroform extract	N-Hexane extract	Ethyl acetate extracts	Petroleum ether extracts
Saponins	+	-	-	-	-	+	-	-
Tannins	-	-	+	-	-	-	-	-
Flavonoids	+	-	+	-	-	-	-	-
Terpenoids	+	+	-	-	-	-	+	-
Napthoquinone	-	-	-	-	-	-	-	-
Inulin	-	+	+	-	-	-	-	-
Glycosides	-	-	-	-	-	-	-	-
Reducing sugar	+	-	+	-	-	-	-	-
Alkaloids	+	+	+	-	-	+	-	+
Soluble phenols	-	-	+	-	-	-	-	-

Table. 8: Preliminary phytochemical screening of aqueous and alcoholic extracts of Unripe Peel of *Musa acuminata*

Phytochemical constituents	Aqueoues extract	Ethanolic extract	Methanolic extract	Acetone extract	Chloroform extract	N-Hexane extract	Ethyl acetate extracts	Petroleum ether extracts
Saponins	-	-	-	-	-	+	+	-
Tannins	-	-	+	-	-	-	-	-
Flavonoids	+	+	+	+	-	-	-	-
Terpenoids	-	+	-	+	-	-	+	-
Napthoquinone	-	-	-	-	-	-	-	-
Inulin	-	+	+	-	-	-	-	-
Glycosides	-	-	-	-	-	-	-	-
Reducing sugar	-	-	+	-	-	-	-	-
Alkaloids	+	+	+	+	-	+	-	+
Soluble phenols	-	+	-	+	-	-	-	-

Table. 9: Total Flavonoid Count in the alcoholic extracts of peel and pulp of Ripe and Unripe banana fruits of *Musa paradisiaca*

Extract		Total Flavonoid Count
Solvent	**Sample**	**TFC (mg QE/g of extract)**
Methanol	Unripe Pulp	90.56
	Unripe Peel	67.48
	Ripe Pulp	54.66
	Ripe Peel	90.56
Ethanol	Unripe Peel	67.48
	Unripe Pulp	80.47
	Ripe Pulp	62.34
	Ripe Peel	50.56

Table. 10: Total Flavonoids Count in the alcoholic extracts of peel and pulp of Pipe and Unripe banana fruits of *Musa acuminate*

Extracts		Total Flavonoid Count
Solvent	**Sample**	**TFC (mg QE/g of extract)**
Methanol	Unripe Pulp	67.48
	Unripe Peel	62.34
	Ripe Pulp	80.3
	Ripe Peel	72.60
Ethanol	Ripe Pulp	90.56

Table. 11: Total Phenolic Content in the alcoholic extracts of peel and pulp of Ripe and Unripe banana fruits of *Musa paradisiaca*.

Extracts		Total Phenolic Content
Solvent	**Sample**	**TPC (mg QE/g of extract)**
Methanol	Ripe Pulp	936
	Ripe Peel	1364
	Unripe Peel	1168
	Unripe Pulp	744
Ethanol	Ripe Pulp	950
	Ripe Peel	952
	Unripe Pulp	1190
	Unripe Peel	2298

Table. 12: Total Phenolic Content in the alcoholic extracts of peel and pulp of Ripe and Unripe banana fruits of *Musa acuminata*

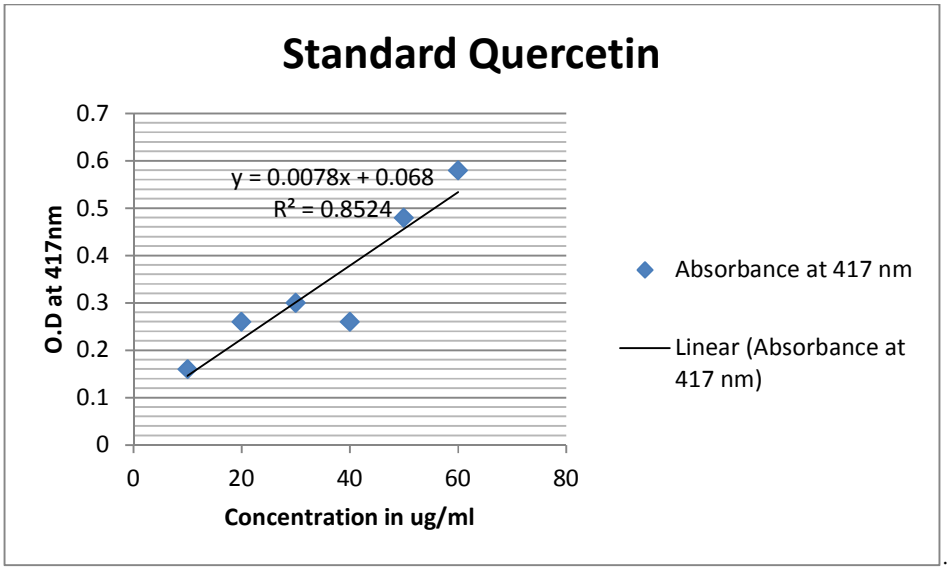
Extract		Total Phenolic Content
Solvent	**Sample**	**TPC (mg QE/g of extract)**
Methanol	Unripe Pulp	744
	Unripe Peel	892
	Ripe Pulp	778
	Ripe Peel	1168
Ethanol	Ripe Pulp	950
	Ripe Peel	897
	Unripe peel	1002

Table. 13: Antioxidant activity of the alcoholic extracts of peel and pulp of Ripe and Unripe banana fruits of *Musa paradisiaca*

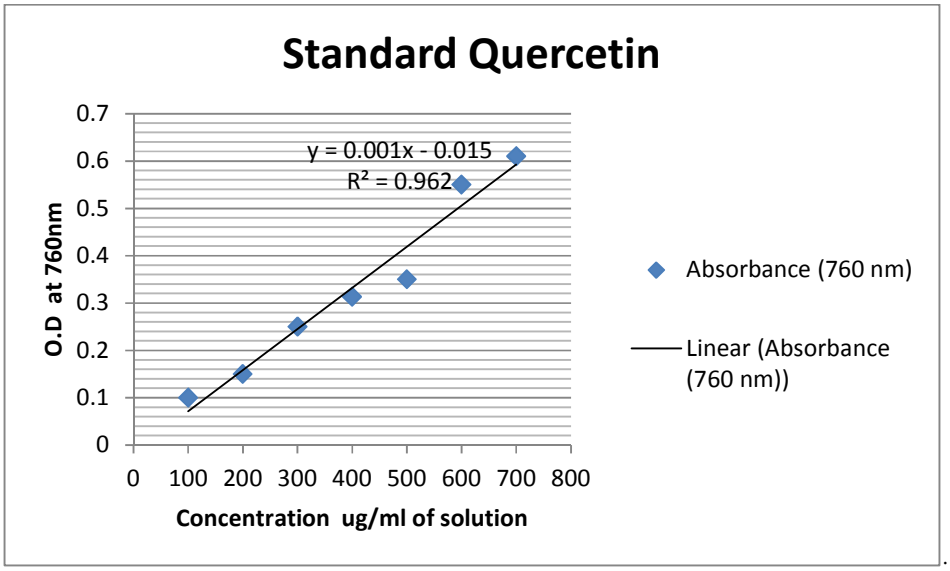
S.No	Solvents	Banana part used	Percentage of inhibition
1	Ethanol	Unripe Peel	68.05
		Unripe Pulp	70.92
		Ripe Pulp	12
		Ripe Peel	43.75
2	Methanol	Ripe Pulp	0
		Ripe Peel	53.47
		Unripe Peel	69.44
		Unripe Pulp	65.27

Table. 14: Antioxidant activity in the aqueous and alcoholic extracts of peel and pulp of Ripe and Unripe banana fruits of *Musa acuminata*

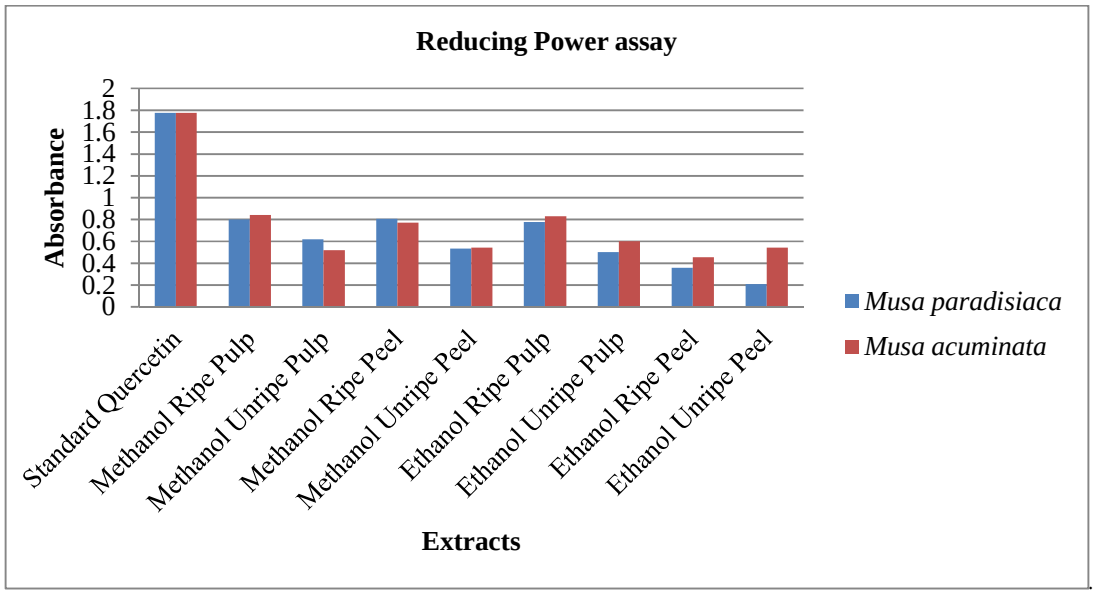
S.No	Solvents	Banana part used	Percentage of inhibition
1	Ethanol	Unripe Peel	80.3
		Ripe Pulp	66.06
		Ripe Peel	56.16
2	Methanol	Ripe Pulp	50.68
		Ripe Peel	69.40
		Unripe Peel	73.51
		Unripe Pulp	85.78



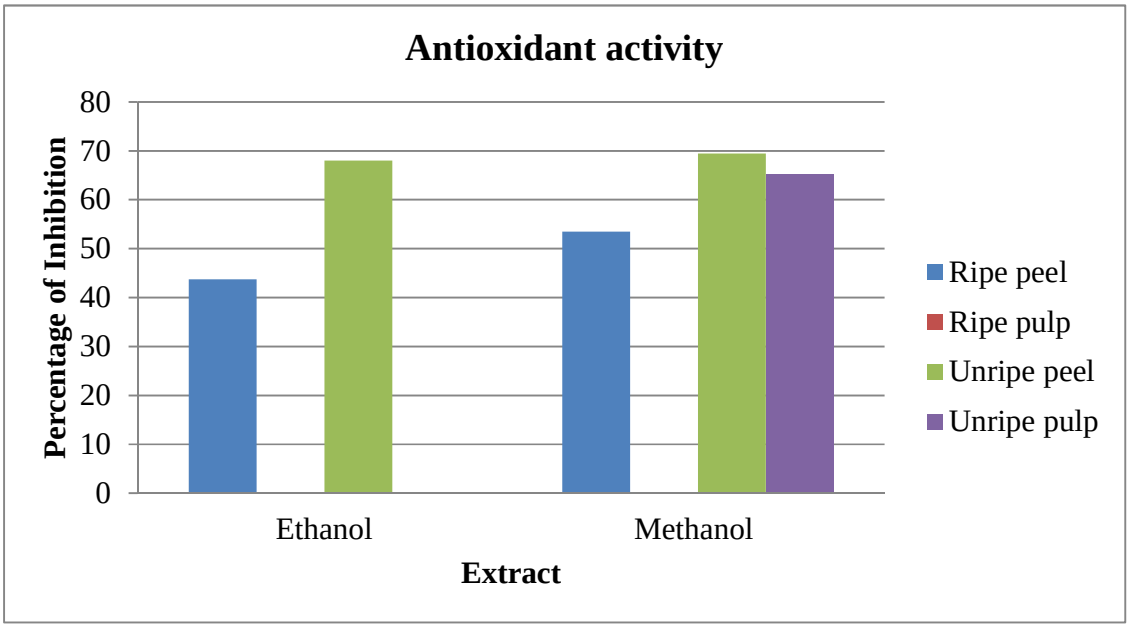
Graph1. Querectin Standard curve for TFC



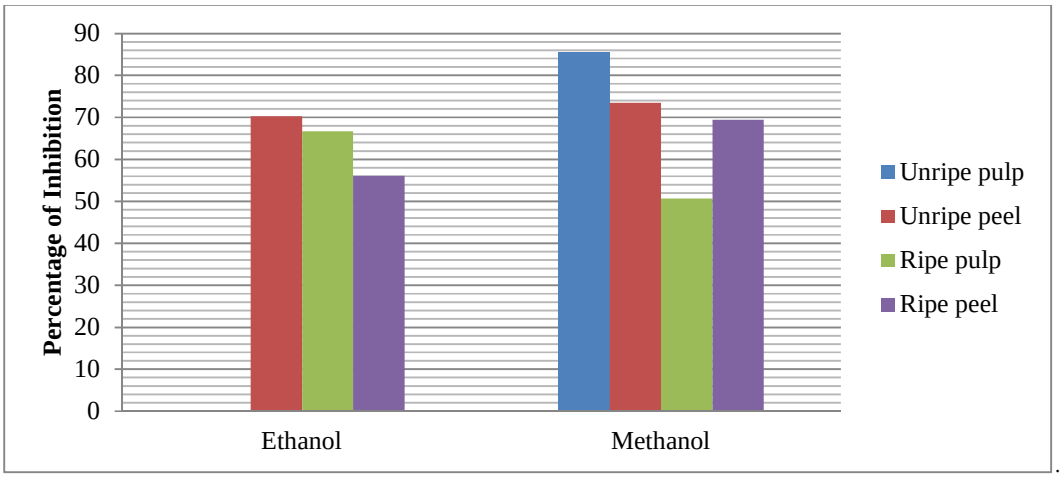
Graph. 2: Querectin Standard curve for TPC



Graph. 3: Reducing power of standard quercetin and aqueous and alcoholic extracts of peel and pulp of ripe and unripe banana fruits of *Musa paradisiaca* and *Musa acuminata*



Graph. 4: Total antioxidant capacity of ethanolic, methanolic and acetone extract of ripe peel and pulp and unripe peel and pulp of *Musa paradisiaca*



Graph. 5: Antioxidant activity of ethanolic, methanolic and acetone extract of Ripe Peel & Pulp, Unripe peel & Pulp of *Musa acuminata*

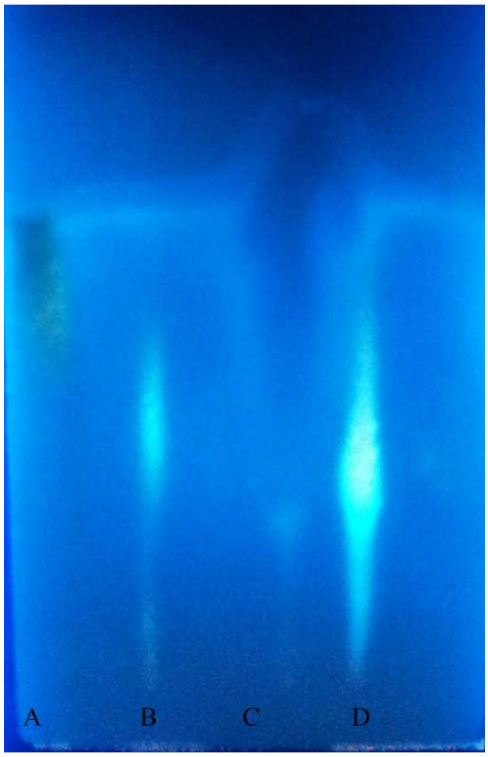


Fig. 1. Thin layer chromatography of (A) standard of quercetin(B) methanolic extract of unripe pulp, (C) ethanolic extract of unripe pulp and (D) methanolic extract of ripe pulp of *Musa paradisiaca*

Fig. 2. Thin layer chromatography of (A) standard quercetin, (B) methanolic extract of ripe peel, (C) Methanolic extract of ripe pulp, (D) Ethanolic extract of ripe pulp and (E) Ethanolic extract of ripe peel of *Musa acuminata*

Fig. 3. Thin layer chromatography of (A) standard quercetin, (B) Methanolic extract of ripe peel of *Musa paradisiaca*, (C) Methanolic extract of ripe pulp of *Musa paradisiaca*, (D) Methanolic extract of ripe pulp of *Musa acuminata* and (F) Ethanolic extract of ripe pulp of *Musa acuminata*

DISCUSSION

Banana is basically familiar tropical fruit which is spreaded over the tropical worl. As far as the secondary metabolites are concerned, it has been observed these secondary metabolites have different therapeutics activities such antioxidant activity, antimicrobial activity, antiinflamatory activity and many more. The purpose of the present research work was to study the comparative analysis of flavonoids showing their respective antioxidant activity in their defined extracts of parts of banana fruit consisting peel and pulp of both ripe and unripe banana of the two species of banana tree i.e. *Musa paradisiaca* and *Musa acuminata*. This became necessary to check the presence of flavonoids in their respective extracts by preliminary phytochemical screenin. It was found that alcoholic extracts of both peel and pulp of ripe and unripe banana fruits of *Musa paradisiaca* and *Musa acuminata* as compared to the previous study that Serotonin, nor-epinephrine,tryptophan, indole compounds, tannin, starch, iron, crystallisable and non-crystallisable sugars, vitamin C, B-vitamins, albuminoids, fats, mineral salts have been found in the fruit pulp of *M. paradisiaca* and *M. sapientum* [15]. Flavonoids were determined by both thin layer chromatography and aluminum chloride colorimetric method. It was found that methanolic extract and ethanolic extract of peel and pulp of ripe and unripe banana fruit of *Musa paradisiaca* and *Musa acuminata* has shown the presence of flavonoid in them. Maximum amount of flavonoid found to be present in methanolic extract of unripe pulp and ripe peel of *Musa paradisiaca* i.e. 90.56 mg QE/ g of extract , whereas ethanolic extract of ripe pulp of banana fruit of *Musa acuminata* has shown the same as 90.56mg QE/ g of extract. As far as phenolic components were concerned, ethanolic extract of peel of unripe banana fruit of *Musa paradisiaca* has shown maximum total Phenolic content such as 2298mg QE/ g of extract as compared to the phenolic component of *Musa acuminata* has shown 1168 mg QE/ g of extract in its methanolic extract of its ripe peel.As compared to the previous studies 8000 GAE µg/g extract in its methanolic extract of banana fruit of *Musa paradisiaca* [16]. Flavonoids glycosides was also found to be present in the methanolic extract of raw pulp and ripe pulp of banana fruit of *Musa paradisiaca* where as methanolic extract of pulp of ripe banana fruit and ethanolic extract of pulp of ripe banana fruit of *Musa acuminata* revealed the presence of anthocyanidins & anthocyanins after spraying with 10% $AlCl_3$. Ethanolic extract of peel and pulp of ripe banana fruit of *Musa acuminata* has also shown the presence of Flavonoid glycosides, where as methanolic extract of peel and pulp of ripe of banana fruit of *Musa paradisiaca*. As compared to the previous studies, two new acyl steryl glycosides Sitoindoside III and Sitosterol myo-inosityl-beta-Dglucoside found to be present in the Gradient solvent extraction of peeled fruits of *Musa paradisiaca* [17]. Antioxidant activity was determined by DPPH free radical scavenging assay and reducing power assay in those extracts of parts of banana fruits that has shown the flavonoids and Phenolic conent in them. It was determined from the present study that 85.38% of inhibition found to be present in the methanolic extract of pulp of unripe banana fruit of *Musa acuminata*, where as acetone extract of peel of unripr banana fruit of *Musa paradisiaca* has shown 73.61% of inhibition against free

radicals. As compared to the previous studies methanolic extract of fruit of *Musa paradisiaca* has shown antioxidant activity [16]. Reducing power has also shown its maximum antioxidant activity in the aqueous extract of peel of unripe banana fruit of *Musa paradisiaca* as well as ethanolic extract of pulp of ripe banana fruit if *Musa acuminata*.

CONCLUSION

We authors would like to conclude from the above study, that flavonoids and Phenolic component found to be present in both the Musa sp., where Unripe pulp and peel of *Musa acuminata* and *Musa paradisiaca* has shown maximum antioxidant and also the presence of polyphenolic flavonoids. Future work includes the purification and quantification of secondary metabolites to use as a where Unripe pulp and peel of *Musa acuminata* and *Musa paradisiaca* traditional herbal remedy.

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